Urbanisation, Housing Demand and Densification: A case study of Shenyang, China

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ABSTRACT

Since the 1990s, China has experienced rapid urbanisation, shifting a massive amount of the rural population into cities. Such urbanisation not only boosts urban economies but also has the potential to enhance people's living conditions. Urban housing, as a hot social-economic topic, has been discussed and analysed by many scholars. Due to a process of rapid urbanisation, housing demand in Chinese cities has experienced tremendous growth, in order the meet people's housing requirements, especially after the national housing reform in the 1990s. Due to this increasing housing demand, the existing housing stock and new housing constructions have resulted in increasing housing densities and intensive urban land-uses, in turn leading to housing densification in large cities.

Shenyang, as the largest city in the northeast of China, has a total population of over 8 million people; with an urban population of 6 million; this is an ongoing and increasing trend. This magnitude of population places pressure on urban issues, and housing is considered to be the *most* influenced section. The new housing constructions being built to fulfil the increasing demand for houses in Shenyang, along with existing housing stocks, have resulted in a high-density urban form. Considering the *Shenyang Urban Overall Development Proposed Plan 2011-2020*, the city aims to position itself as not only an economic and financial centre but also an integrated transportation and information hub for the northeast of China. The plan also seeks to limit the residential land-use inside the urban core. This situation, with increasing urbanisation, will intensify specific housing issues, such as high housing demand, increasing housing prices and excessive high-density living. With those concerns in mind, this thesis aims to research and discuss these urban issues in Shenyang, focusing on rapid urbanisation, housing demand, and housing densification.

Based on empirical urbanisation models, the thesis confirms the significance of economic factors and housing investment to urbanisation. With a further discussion on migration, the thesis explains that Shenyang's urbanisation is not only a simply spontaneous action of rural-urban migration but also acutely shaped by political behaviour. The thesis also explains that Shenyang has abilities and advantages to attract even more migrants. Focusing on housing investment, the thesis analyses different sources of investment and highlights the importance of the role of state-owned enterprises (SOEs) in existing and future housing development.

Using housing demand models, it is concluded that housing in Shenyang is still a life necessity rather than investment goods for people. The income discussion shows the transformation of people's notions on housing from the old welfare housing provision to house purchasing, implying the significance of the Housing Provident Fund (HPF) system. The housing price discussion explains the effects of the housing reform on housing prices and housing transactions, and it highlights migration as the main source of population growth, leading to increased housing demand and prices. The demographic analysis shows that household size has an influential impact on Shenyang's housing demand and that increasing marriage competition leads to a demand for housing for families with sons and newly married couples. The thesis also analyses commuting costs and residential expenditures, which help to explain people's preference to settle further away from the city centre and people's notions about residential expenditures at different stages of housing development.

Based on different levels of spatial aggregation, the thesis investigates the housing densities for Shenyang. It is concluded that urban housing preferences are for high buildings and that housing densification occurs in both urban and suburban areas. Due to limited residential land, massive high-rise building projects are inevitable in Shenyang. The thesis also discusses housing vacancy, which has resulted in either massive new housing constructions and housing stock hoarding or increasing housing prices and the policy of restricting house purchases.

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BCR	Building Coverage Ratio
CBD	Central Business District
CPI	Consumer Price Index
DETR	Department of the Environment Transport and the Regions
DI	Domestic Investment
dph	dwelling per hectare
ECH	Economic and Comfortable Housing Programme
FAR	Floor Area Ratio
FDI	Foreign Direct Investment
FDL	Finite Distributed Lag
FSR	Floor Space Ratio
GDP	Gross Domestic Product
GIS	Geographic Information System
GNP	Gross National Product
HI	Housing Investment
HMTI	Investment of Hong Kong, Macao and Taiwan
HPF	Housing Provident Fund
hrh	habitable room per hectare
MPI	Multidimensional Poverty Index
NI	Nominal Investment
OLS	Ordinary Least Squares
PI	Investment of Private Company
PRC	People's Republic of China
REI	Real Estate Investment
SEI	State-owned Enterprise investment
SI	Shareholding Company investment
SOE	State-owned Enterprises
USD	US Dollar

1. Introduction

1.1. Research background

Urbanisation is currently a widely discussed topic in the field of urban development throughout the world, and it refers to the population shift from rural to urban areas and the gradual increase in the urban population in a given area (Spence et al., 2008, Williamson, 1988, McCarthy and Knox, 2005). Urbanisation is described as a two-way process that does not just involve movements from villages to cities and changes from agricultural occupations to business, trade and services, but also changes in the attitudes and behaviour patterns of migrants (Tisdale, 1942, Anderson, 1964, Dijkstra and Poelman, 2014). Nowadays, urbanisation has been understood and discussed in terms of concepts other than just population; it has been studied in a range of disciplines, such as urban planning, geography, sociology, urban economics, etc. (Gries and Grundmann, 2018, Dong, 2001, Zhang, 2002, Song and Zhang, 2002, Drakakis-Smith, 2012, Bertinelli and Strobl, 2007).

In the 20th century, most western countries entered a period of high levels of urbanisation (Satterthwaite, 2005). By the end of the 20th century, the urbanisation rates in the EU and North America were 72 percent and 79 percent, respectively, some of the highest urbanisation rates in the world (United Nations, 2018).

In the 21st century, the main protagonists of urbanisation include a large number of developing countries, especially China, as the biggest developing country with the largest population and the second-largest economy in the world (Song and Zhang, 2002, Zhang, 2002, Shen, 2006). According to the United Nations (2018), China's urbanisation rate was only 16 percent in 1960 and it had reached 36 percent by the end of the 20th century. By the end of 2017, China's urbanisation rate stood at 58 percent, a significant increase, but there is still a large gap between China and developed countries (United Nations, 2018). The United Nations (2018) estimates that the global urban population will reach 6.68 billion in 2050, and China's urban population is expected to increase by 0.25 billion by that time. Compared to other urbanised countries, the noticeable urbanisation in China is not only a reflection of a large increase in the population size, but of a large scale

migration from rural to urban areas under the household registration (*hukou*) system[1] (Huang et al., 2014). This urbanisation is primarily due to changes in the criteria for town establishment. The criteria promote the development of small cities and towns, while making a great effort to avoid the issues associated with massive urban centres in other developing countries, such as unemployment and disease (Ebanks and Cheng, 1990). Furthermore, the *hukou* system does not only ensure people with the hukou status enjoy relevant social welfare, but also plays an essential role on regulating population distribution with respect to urban areas. Due to its impacts on population distribution, especially directing migration from rural to urban areas and controlling migration at appropriate levels, it is considered to be a standard to measure urbanisation progress (Chan and Zhang, 1999).

Housing is an inevitable key topic when discussing urbanisation because it is not only an essential urban element but also a basic living requirement for human beings (Drakakis-Smith, 2012, Dong, 2001, Wu, 2001, Yao et al., 2014). Meanwhile, as a unique consumption good with long-time durability and spatial fixity, housing is much more expensive than most other commodities, and purchasers typically take much longer to decide to purchase a house than they do with other goods (Mayo, 1981, Megbolugbe and Marks, 1991). Rapid urbanisation triggers huge migrations into cities, and this migration and the natural growth of the population result in an increase in housing demand (Dong, 2001). To some extent, the potential of the housing market in a city depends mainly on its level of urbanisation and type of urbanisation.

After the housing reform in the 1990s, China's housing market entered a new boost period. Housing demand, driven by rapid urbanisation and economic growth, is rising fast, particularly in some large cities (Chen et al., 2011b, Chen et al., 2011a, Wang and Murie,

[1] The *hukou* system is a household registration system applied in mainland of China. Due to its connections to social welfare programmes provided by the government, people with different *hukou* status (often identified as rural *hukou* status and urban *hukou* status) enjoy different benefits, such as retirement pension, education, health care, *etc.* In detail, the *hukou* system was started in 1958 and was considered as a tool to control rural-urban migration. According to its regulation, all households were tied to a particular place and divided into agricultural (rural) or non-agricultural (urban) categories, and each person was assigned either rural or urban *hukou* status. Population mobility at the beginning stage of the *hukou* system was strictly controlled. After 1978, due to the opening-up, rural people have gradually been allowed to work and reside in urban areas, in order to meet labour force requirement of economic development. The liberalisation of such population movements has been carried out gradually by the government. During this period, migration control with the hukou system linked with national urban development strategy. In the 21st century, the *hukou* system has become less rigid for migrants, helping local governments to attract sufficient labours for their urban development, meanwhile it also helps to control excessively massive migrants moving to cities.

2000). Meanwhile, higher living costs, especially higher house prices, mean that there is a mismatch between house prices and people's incomes. In some cities, housing shortages have caused an escalation of housing prices, which leads to an imbalance between demand and supply (Arkaraprasertkul, 2012). Also, housing shortages can result in social issues, for example homelessness. According to the first Chinese national housing census in 1985, 3.2 percent of urban households were homeless and 12.8 percent of urban households were overcrowded (Shaw, 1997). In 2006, a national survey by the National Working Committee on Women and Children showed that there were at least 1 million vagrant and begging minors without a home in China (Kennett and Mizuuchi, 2010). To meet this increasing housing demand, and in pursuit of large profits due to the increasing house prices, more developers have jumped into the housing market making massive investments, which has resulted in over-development of housing in some areas. After ten years of rapid construction, housing stocks in some cities have been hoarded, and the new imbalance is now that housing supply exceeds demand (Chen et al., 2011a).

China's rapid economic growth has also strongly influenced the reconfiguration of urban space and marketed-oriented land development, which has *densified* the inner-city areas and expanded the urban network to its outer and undeveloped parts (Wu, 2001). Through this process, many large cities have experienced densification [2] and expansion simultaneously, particularly in the spatial allocation of housing, due to the limited residential land supply in inner-urban areas (Arkaraprasertkul, 2012). Such densification and expansion can be reflected in the changes of housing densities, which the terms are named as housing densification and expansion (Broitman and Koomen, 2015). These two processes are also related to residential land provision, which is another essential element for housing development, because of the spatial fixity of housing.

Furthermore, compared to some western countries such as the UK (Bramley and Power, 2009, Dempsey et al., 2012, Department of the Environment Transport and the Regions, 1998), Denmark and Sweden (Bamford, 2009) and The Netherlands (Broitman and Koomen, 2015), which have considerable proportions of single-family housing and use the number of housing dwellings per land area as a unit for measuring densities, building

[2] Densification is proposed as a solution to a compact urban form in dispersed growing cities in the field of urban policies. Housing densification is defined as a transformative process indicated by maximum land use and high-rise, multi-family housing, encouraged by the housing shortage and accelerated by the land supply restrictions.

coverage ratio (BCR) and floor area ratio (FAR) are commonly used in China, because medium-rise or high-rise buildings are widely used for higher population densities in urban areas (Wu and Li, 2010, Pan et al., 2008, Ng, 2009, Pont and Haupt, 2010). This thesis will apply these items to demonstrate the housing densities for the case-study area.

1.2. Research area and research motivations

As is now well known, China has become one of the fastest developing countries across the world (Qianqian, 2011, Chen et al., 2014). Despite the influence of the Asian Financial Crisis in 1997 and the Global Financial Crisis in 2007, China's economy has still maintained a high speed of growth. From Figure 1.1, during the Asian Financial Crisis and the Global Financial Crisis, we can see that China's Gross Domestic Product (GDP) growth rate stayed at around a remarkable 8 percent. After the crisis, China's economy recovered gradually with an increasing GDP growth rate (Lardy and Subramanian, 2011).

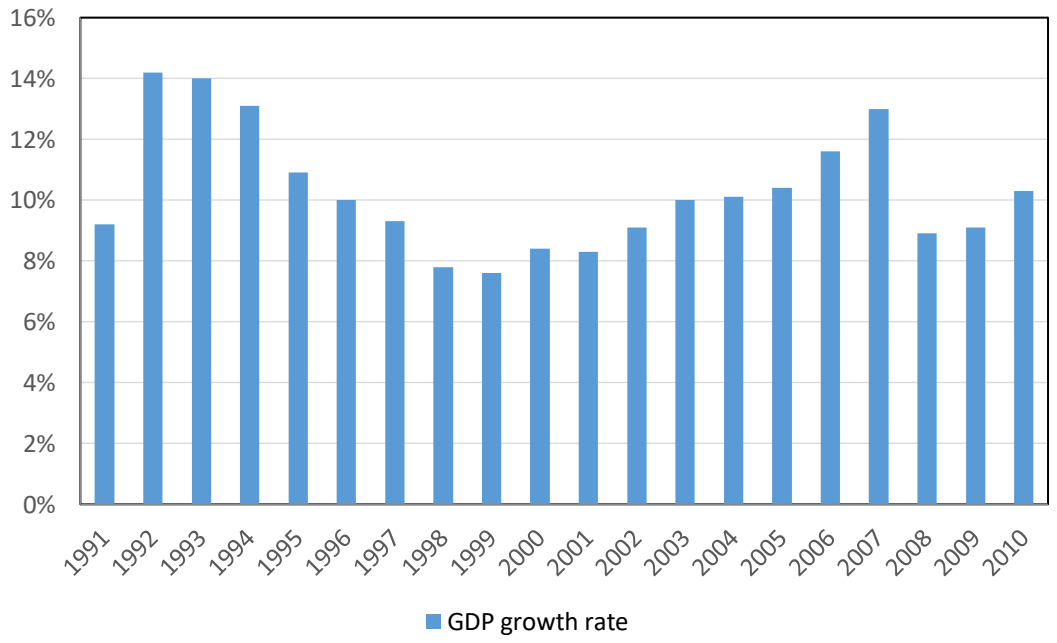

Figure 1.1 GDP growth rate in China from 1991 to 2010

Source: National Bureau of Statistics of China (2012)

The housing market is considered to be not only a significant industry in relation to the entire economic system but also a barometer for the economy (Brady, 1967, Wu, 2001, Huang, 2004). Since the housing reform in the 1990s, China's housing market has been experiencing a rapid development (Wang and Murie, 1999, Wang and Murie, 1996). After 2000, China experienced a rapid increase in urbanisation that provoked massive demand for new houses, and was considered by many as a great developing opportunity for the Chinese housing market (Yao et al., 2014). Meanwhile, supported by policies of land, finance and local governments, the high returns of housing development attracted massive amounts of investment from different sources, such as domestic investment, investment from Hong Kong, Macao and Taiwan, and foreign direct investment (Chen and Zhu, 2008).

The rapid housing development in China has benefited from the implementation of the opening-up policy (Wu, 2001, Harvey, 2005). In the decades since the opening-up of the economy, both fast economic growth and a rapid increase in personal disposable income have stimulated people's desire to purchase a house. As a result, housing now accounts for important personal wealth (Yi and Huang, 2014).

Due to the rapid urbanisation, especially in the large Chinese cities, a large number of migrant workers decided to reside in urban areas. This led to considerable housing demand, with a subsequent dramatic increase in housing prices and housing purchases (Zheng and Liu, 2005, Li, 2005b, Chow and Niu, 2015). Meanwhile, during the same period, most other countries' housing markets experienced economic depression, while the housing market in China sustained growth (Zhang, 2014b). Besides this rapid development, other features of Chinese housing development are attracting attention. The super-fast rise in housing prices in some cities has exceeded most people's affordability, even though personal disposal income has increased steadily (Wang et al., 2017). Many cities have over-developed their housing, not only imposing higher densities on the urban areas but also expanding too far into suburban and rural areas (Yao et al., 2014). Consequently, besides the over-high housing prices, other issues related to the rapid housing development have emerged, such as the impact of high-density living on the environment (Yeh, 2011), imbalanced land supply for residential land-use and other

functional land-uses (Long et al., 2014), housing vacancy and even ghost cities[3] due to the imbalance in the demand and supply of housing (Chi et al., 2015). Therefore, Chinese housing topics and issues related to housing have attracted and intrigued scholars to investigate further.

In 2010, the State Council of China approved plans to allow Shenyang and eight nearby cities to establish a comprehensive reform pilot zone[4], named the Shenyang Economic Zone (Han et al., 2011). This zone covers 75,000 km^2, with a population of 23.6 million and an average urbanisation rate of 65 percent. The zone, as the core area representative of the old industrial base in the northeast of China, is an integration of resource-based cities and industrial cities. Its industrial system mainly comprises machinery, metallurgy, petrochemical, coal, electricity and building materials, and it is the earliest and largest industrial base in China, with complete equipment manufacturing and a raw material industry.

Shenyang is the central city of Shenyang Economic Zone and the largest city in the northeast of China. As the capital city of Liaoning Province with hundreds of years of history, Shenyang used to be a key industrial base in the last century, and now it has developed into an economic and cultural centre, with 8 million total population and 12,860 km^2 of land. Since the opening-up of the Chinese economy, due to its geographic location and the leading role of its economy in both Liaoning Province and the northeast of China, Shenyang has attracted massive investment in its urban development. This has been accompanied by a considerable number of migrants moving into the city, which has boosted its urbanisation to an unprecedented level (Shenyang Statistical Bureau, 2015).

According to *Shenyang Urban Overall Development Proposed Plan 2011-2020*[5], the urban population is estimated to reach 7.25 million by 2020, with 2 million growth

[3] A ghost city or ghost town refers to an abandoned city or town that usually contains substantial visible remaining buildings and infrastructure. In the Chinese housing context, ghost cities refer to those cities that have been over-developed on housing programmes with high housing vacancy rates, for example, Kangbashi District in Ordos and Yujiapu Financial District in Tianjin. The reason for being a ghost city is over-estimating housing demand and insufficient purchasing power for housing.

[4] The comprehensive reform pilot zone is a new type of economic zone launched by China's government, compared to the special economic zones built in the 1980s. The purpose of launching this comprehensive reform pilot zone is to promote local economic and social development, which complies with the trend of economic globalisation and regional economic integration.

[5] *Shenyang Urban Overall Development Proposed Plan 2011-2020* is a master plan for the period between 2011 and 2020, formulated by the urban and rural planning office of Shenyang Municipal Government, approved by the State Council.

compared to 5.28 million at the end of 2014. The urbanisation rate is estimated to reach 87.5 percent. This huge population increase indicates rapid urbanisation, and the urbanisation level will reach a historically high level. Mills et al. (1986) indicated that urbanisation has accompanied economic development in both developed and developing countries, and it has occurred because of massive shifts of labour and capital from predominantly rural to predominantly urban activities in the course of economic development. Drakakis-Smith (2012) indicated that migration to cities is another big cause of urbanisation, apart from the natural growth of the population, and rural migrants have increasingly moved towards the towns and cities within their own areas. He also indicated that large cities can be more attractive to migrants than medium and small cities, because they have economies of scale and can provide more living resources and job opportunities. Many scholars have used economic indices and functional forms to estimate the relationships between urbanisation and economic development, such as Mills (1972), Mills et al. (1986), Henderson (2000), Zhang (2002) and Annez and Buckley (2009). Furthermore, as the hukou system works on directing migration from rural to urban areas and controlling migration at appropriate levels, it brings a research motivation on researching the hukou system on Shenyang's urbanisation. Based on the above statements, the first motivation of this thesis is to research Shenyang's urbanisation with economic factors and contributions of Shenyang's migration to the urbanisation with the hukou system. In order to build a research connection between urbanisation and housing, this thesis will also *test the influence of housing investment on urbanisation*.

Because rapid urbanisation causes a massive population in cities, housing demand increases correspondingly (Malpass, 1986). Also, housing is a special consumer good that can be explained by the consumption theories that mainly focus on people's income and market prices (Megbolugbe and Marks, 1991). Apart from housing prices and income, housing demand has been related to demographic factors (Berson and Berson, 1997) and locational factors (Alonso, 1964, Quigley, 1976). Furthermore, the *Shenyang Urban Overall Development Proposed Plan 2011-2020* aims to achieve 35m^2 per capita, and this target considers not only migrants moving into the city but also the existing residential population in the urban cores transferring to the suburban areas. Thus, the second research motivation arises from how the increasing urban population has influenced the housing demand in Shenyang and how the different factors mentioned above have influenced this housing demand.

According to Somerville (1999), and DiPasquale and Wheaton (1994), increasing housing demand results in new housing construction. Assuming that urban land is constant or changes only slightly, this new housing constructions causes housing density to change. As a consequence, housing densification occurs in urban areas, and this will extend to suburban areas as housing expansion (Loibl and Toetzer, 2003, Broitman and Koomen, 2015). According to the *Shenyang Urban Overall Development Proposed Plan 2011-2020*, apart from the individual housing space target, housing development also includes: adjusting the layout of residential land-use; controlling the residential land expansion within the urban cores; and accelerating new housing construction in the suburban areas. These tasks aim to balance the housing distribution in both the urban cores and suburban areas, in order to control the over-high housing densities and relieve the pressure on residential land in urban cores. Thus, the third research motivation comes from the housing densification and expansion caused by the massive new housing constructions in both the urban cores and suburban areas.

1.3. Research questions and objectives

Based on the introduction of the research area and the three research motivations briefly discussed above, the research questions have been formed. First, what is the current situation with regard to Shenyang's urbanisation? Does the urbanisation progress match the target set in the *Shenyang Urban Overall Development Proposed Plan 2011-2020*? What factors significantly influence urbanisation? Second, considering the rapid urbanisation, what is the situation with regard to housing demand for residents in Shenyang? What factors drive the housing demand, and how do they drive it? Third, considering the massive housing construction that occurs each year, what are the housing densities in the urban and suburban areas? Is Shenyang becoming more compact in the urban core area, or are new housing constructions balanced in each urban and suburban district?

Based on the questions above, in sum the thesis aims to investigate each topic: urbanisation and housing; housing demand; and housing densification, for the city of Shenyang. Meanwhile, another research purpose for this thesis is to investigate the status and level of success of urbanisation and housing development in Shenyang, based on the target set in the *Shenyang Urban Overall Development Proposed Plan 2011-2020*.

According to the motivations and questions above, the thesis will build a reasonable and logical connection between urbanisation, housing demand and housing densification, as follows: the increasing urban population leads to rapid urbanisation (Drakakis-Smith, 2012), and this rapid urbanisation triggers a rise in housing demand (Malpass, 1986); the increasing housing demand attracts more investment into the housing market, which results in massive new housing construction (Topel and Rosen, 1988, Green, 1997, Chen et al., 2011b, Chen et al., 2011a). The consequence of the new housing constructions is a change in housing densities, which will take place in both the central urban areas and outside suburban areas (Loibl and Toetzer, 2003, Broitman and Koomen, 2015).

Furthermore, urbanisation is a consequence of economic development, which can be understood and explained by urban economics (Mills et al., 1986, Zhang, 2002, Henderson, 2003, Davis and Henderson, 2003). The essence of urbanisation is a massive shift of labour and other inputs from rural to urban areas, and the shift can be explained by the relationship between the demand and supply of urban economics (Mills et al., 1986). In urban economics, GDP per capita and labour force share are the two main factors that influence urbanisation (Mills et al., 1986, Zhang, 2002, Henderson, 2003). Also, in order to build a connection between urbanisation and housing, this thesis introduce housing investment as an important variable in the model to test whether it is significant to urbanisation. Thus, for Shenyang's urbanisation, a main purpose is to research how those urban economic factors drive urbanisation.

Based on neoclassical consumption theory, housing demand is determined by consumers' income, market prices and consumers' preferences (Megbolugbe and Marks, 1991). Income can influence housing demand because it is the main monetary source for homebuyers (Megbolugbe and Marks, 1991). Fluctuations in housing prices reflect the situation of demand and supply in housing markets (Fair, 1972, Glaeser et al., 2005, Chow and Niu, 2015). In housing research, the elasticities of income and price show how sensitively they respond to housing demand. In addition, demographic factors such as population and household size have also been proven to influence housing demand (Mulder, 2006, Mayo, 1981). Thus, researching how these factors drive Shenyang's housing demand is another purpose of this thesis.

Rapid urbanisation causes increasing housing demand, which results in new housing constructions (Delmelle et al., 2014). This housing development results in changes in housing density, which leads to housing densification inside a given area and expansion outside the area (Broitman and Koomen, 2015). Also, allocating residential land and land-use transitions from other lands to residential land can influence housing densities (Broitman and Koomen, 2015). They can result in different urban forms, such as urban sprawl and urban compactness (Jordan et al., 1990). Thus, studying the housing density and its changes, including urban land-use transitions, is another main research focus.

Following the brief explanations above, this thesis is based on three main research questions related to the urbanisation, housing demand, and housing densification of Shenyang, as follows:

1. With regard to urbanisation, according to the *Shenyang Urban Overall Development Proposed Plan 2011-2020*, the urban population is estimated to reach 7.25 million in 2020, with a growth of 2 million compared to 5.28 million at the end of 2014. The research question for this section is: why has urbanisation increased, and which factors influence this urbanisation?
2. With regard to housing demand, due to the fact that increasing urbanisation results in increasing housing demand, the research question for this section is: which factors influence housing demand in Shenyang and how do these factors influence housing demand?
3. With regard to housing densification, due to the fact that increasing housing demand leads to new housing constructions and housing densification, the research question for this section is: what are the features of housing densification in Shenyang in a spatial sense?

Based on the main three research questions, sub-questions have been formulated for each topic, and the research objectives established, as shown in Table 1.1.

Table 1.1 Research questions and research objectives for urbanisation

Urbanisation	
Main research question	
Why has urbanisation in Shenyang increased, and which factors influence this urbanisation?	
Research Questions	**Research Objectives**
RQ1. In urban economics, what are the key driving forces that cause the rapid urbanisation of Shenyang? RQ2. How do those drivers influence urbanisation? RQ3. Is there a relationship between urbanisation and housing investment?	RO1. To explore urbanisation, including the definition, advantages and causes of rapid urbanisation. RO2. To make clear the relationship between urbanisation and urban economic development. RO3. To identify the key factors that drive Shenyang's urbanisation. RO4. To research migration as the main reason for the rapid urbanisation of Shenyang, and to discuss how the *hukou* system works to control migration. RO5. To research different sources of housing investment in Shenyang and explain how they drive Shenyang's housing development.

Table 1.2 Research questions and research objectives for housing demand

Housing Demand	
Main research question	
Which factors influence housing demand in Shenyang and how do these factors influence housing demand?	
Research questions	**Research objectives**
RQ1. In urban economics, what are the main drivers of the increasing housing demand in Shenyang? RQ2. How do those factors work? RQ3. Are there any social factors that can explain the increasing housing demand in Shenyang?	RO1. To distinguish housing need and housing demand, and to know why housing is a unique good compared to other products. RO2. To study housing demand models in urban economics, focusing on economic factors including income and housing prices, and also to research how demographic factors and other factors may influence housing demand. RO3. To identify the main drivers that influence the housing demand in Shenyang. RO4. To explain how and why the factors influence Shenyang's housing demand, and then to identify corresponding housing problems due to the high housing demand.

Table 1.3 Research questions and research objectives for housing densification

Housing Densification	
Main research question	
What are the features of housing densification in Shenyang in a spatial sense?	
Research Questions	**Research Objectives**
RQ1. What is housing densification? Are there any connections between housing densification and urban compactness? RQ2. What are the tools for measuring housing density? RQ3. What is the situation of housing densification in Shenyang, and what are the most appropriate tools to measure the densification for the case of Shenyang?	RO1. To explore housing densification, including its definition and influencing factors and to make clear the relationship between housing densification and urban compactness. RO2. To distinguish the measures of housing density, and to select the most appropriate measures of housing density for the case of Shenyang. RO3. To research the housing densities of Shenyang in different urban levels, and to explain the changes in the housing densities during the research period. RO4. To discuss the housing problems of Shenyang based on densification research.

1.4. Research design

This section will present a comprehensive discussion on how this research was designed. As discussed in Section 1.4, this thesis is a single case with three embedded units, and they each have their theoretical connections: the increasing urban population leads to rapid urbanisation, and this rapid urbanisation triggers a rise in housing demand. Meanwhile, the increasing housing demand attracts more investment into the housing market, which results in massive new housing constructions. The consequence of building these new houses is a change in housing densities, which will take place in both the central urban areas and outside suburban areas. Following the theoretical connections above, the research design will follow the normal process of case study design. The following sections discuss how to design each embedded unit, including establishing the logic, selecting analytic techniques, collecting evidence (data), and analysing and reporting results.

1.4.1. Case-study area

The case study method enables a researcher to examine the data within a specific context and to investigate contemporary real-life phenomena through detailed contextual analysis. In most cases, a case study selects a small geographic area as the study subject (Zainal, 2007). For this thesis, the case study focuses on the contemporary phenomenon of Shenyang's urban housing, which defines the location of the case study as a specific geographic area. Thus, before starting the three embedded units, it is necessary to describe the area of the case study and to present a background introduction. Also, in order to investigate urban housing for a single Chinese city, it is necessary to review the subject of urban planning. Moreover, in order to introduce urban housing comprehensively, the thesis chooses housing development and housing policies as two focuses. Thus, the thesis will set aside a separate chapter for introducing all the background information.

Following the above considerations, first of all, the thesis will present an overview and historical introduction to the case-study area. This section contains general information about the area, including geographic information and the administrative divisions of the area, population distribution and economic circumstances. This section gives a descriptive impression to readers who are not familiar with Shenyang's circumstances.

Secondly, the thesis will review neoliberalism's (see Harvey, 2005) influence on the Chinese economy, preparing to discuss urban planning's influence on urbanisation and the housing system. In order to give a comprehensive discussion on neoliberalism, the thesis will review the definitions of different scholars, and then explain how neoliberalism applies to the Chinese economy and urban development, in terms of the two essential features of neoliberalism; marketisation and decentralisation.

Thirdly, in order to investigate urban housing for a single Chinese city, it is important to review urban planning. Yeh and Wu (1999) indicate that there is a strong link between urbanisation and the urban planning system, and in order to understand the urban system we need to not only look at historical aspects, but also understand how the contemporary urban planning system functions. With this consideration, the thesis will present a background introduction to Chinese urban planning in three historical phases and its impacts on urban development.

Then, the thesis reviews Chinese housing development. This section contains two parts: housing market development and housing policy development. The first part will describe housing market development in four historical stages with housing investment statistics and significant events. The second part will focus on housing policies and explain how significant policies have been implemented at different historical stages.

Finally, the thesis will provide an overview of Shenyang's housing development, focusing on significant events and policies. Considering that the national housing reform started in 1995, this section reviews the Shenyang context from 1995 to the present in four historical phases. The review contains the statistics on housing investment, housing construction and housing sales, which provide a comprehensive background introduction to Shenyang's housing for the reader.

1.4.2. Research designs for urbanisation

As the first embedded unit of the urban housing of Shenyang, the urbanisation section aims to answer the research question of why urbanisation has increased at such a rate, and which key factors are influencing this urbanisation. This section also aims to build a connection between urbanisation and urban housing. In order to answer the research questions and achieve the research aim, the research design of this section is as follows.

Firstly, the thesis will review the definition of urbanisation and its main causes, and then describe the urbanisation circumstances of the world and China. Because urbanisation is considered to be a prerequisite for urban housing and is positively linked to the economy in China (Zhang, 2002), it provides a premise that the urbanisation of Shenyang can be investigated through knowledge of urban economics. According to this premise, the thesis will review the literature of urbanisation within urban economic development. Meanwhile, according to the theoretical connection between urbanisation and urban housing, the thesis will review China's urban housing in relation to its urbanisation. Within urban economics, because housing investment is a significant contributor to economic growth and urban development (Topel and Rosen, 1988, Green, 1997, Chen et al., 2011a), the thesis will also review housing investment and its impact on urbanisation.

Secondly, after reviewing the urbanisation context and identifying the key influential factors of urbanisation, the thesis will select an appropriate analytic technique to analyse the urbanisation of Shenyang and to raise research hypotheses. The purpose of this section is to choose particular indices of urban development reviewed from the literature and particular functional forms to estimate the relationship between urbanisation and economic development, and to identify/analyse the relationship between urbanisation and urban housing. Such statistics will yield quantitative estimates of the importance of each variable and allow us to test each research hypothesis. Then, the thesis will talk about data issues, including data collections and data adjustment. Data collections will focus on data type and data source, and will explain the choice of each specific period of data and how reliable the data source is. The purpose of data collections is to make sure that the data is reliable, robust and accurate for the analysis.

Thirdly, based on the estimated functional forms and the data, the results will be received. It is expected that each variable will significantly influence urbanisation, particularly housing investment. Besides the analysis of the results, the thesis will carry out a further discussion on migration as an important part of urbanisation. The discussion aims to explain why Shenyang's urbanisation is increasing and how the *hukou* system helps to control this trend. Then, the thesis will focus on housing investment and discuss how different types of housing investment work in the housing market.

1.4.3. Research designs for housing demand

Housing demand is the second embedded unit of the urban housing of Shenyang in the thesis, and this section aims to answer the research question of which factors influence the housing demand of Shenyang and how those factors influence the housing demand. In order to answer the research questions, the research design of this section is as follows.

Firstly, the thesis will distinguish between housing demand and housing need, because the two terms often appear in housing studies and policies and may cause confusion to readers. Because housing is a special consumption good with unique characteristics in the market, the thesis will use neoclassical consumption theory to introduce housing demand and then discuss the nature of housing. Then, the thesis will review the factors that influence housing demand, mainly focusing on economic and demographic factors and how these factors perform in housing demand models, in order to prepare model setting afterwards.

Secondly, for the method and analytic technique for testing the factors of housing demand, the housing demand equation will be estimated. The purpose of this section is to choose particular variables reviewed in the literature to estimate appropriate models for testing the housing demand in Shenyang. The estimation of the models starts with a basic housing demand model, and then other influential factors will be introduced. The model estimation also considers partial adjustment, so the model estimate will include when the housing market is in equilibrium and disequilibrium. Then, the thesis will talk about data sources and data adjustment due to inflation, in order to ensure that the data are reliable and correct for the analysis.

Thirdly, based on the model estimation, the model results will be presented and discussed. Ideally, the thesis will reveal variables that significantly influence housing demand. If not, the thesis will carry out a further analysis and discussion for each variable.

1.4.4. Research designs for housing densification

Housing densification is the third embedded unit of urban housing in Shenyang, and this unit aims to answer the research question about housing densification in Shenyang in a spatial sense. In order to answer the research questions, the research design of this section is as follows.

Firstly, the thesis aims to identify housing densification using its relationship with urban compactness through literature discussions. Then, the thesis aims to choose appropriate measures for analysing Shenyang's housing density. In order to achieve this aim, the thesis will review and compare different measures of density and their specific applications, and then select the most appropriate measures for the case of Shenyang. Moreover, as the other important element of housing densification, urban land-use will be reviewed, including theory discussions and the specific circumstances in China.

Secondly, the thesis aims to select a research method for housing density. In order to achieve this aim, the thesis will discuss the method with selected density measures. Because the thesis wishes to present the spatial housing densification of Shenyang, it will also review the method of spatial aggregation and explain how the method applies to the housing densification of Shenyang. Then, the data collection will be discussed. The purpose of this section is to explain how the data works with the spatial aggregation method.

Thirdly, the thesis will analyse densification and the results. Due to the application of spatial aggregation, the analysis will focus on each spatial level of the city, which will not only give a full sense of densification but also show comparisons between urban and suburban districts. The purpose of the comparisons is to show whether housing densities are balanced at the urban district level and whether the city has a trend towards compactness or sprawl. The thesis also aims to discuss changes to urban land-use. The purpose is to present how other land-uses influence residential land-use for housing, which can help to explain housing densification. The thesis will discuss housing space per capita to reveal the issue of housing vacancy in Shenyang.

1.5. Thesis structure

Based on the research designs, the thesis contains seven chapters after the introduction, and the thesis structure is as follows:

Chapter 2 presents the background of Shenyang and the Chinese urban housing context. Besides the overviews of Shenyang and the history of Shenyang, the chapter discusses neoliberalism's influence on the Chinese economy and urban planning. Then, it presents the urban system and its impacts on urban development in each historical phase. This chapter also seeks to review Chinese and Shenyang's housing development, focusing on

significant events and corresponding regulations and policies published in each historical phase. This chapter provides readers with an overall perception of both China's and Shenyang's urban housing context and leads into the topics of urbanisation and housing in Shenyang.

Chapter 3 presents reviews of the existing literature for the three embedded units. The urbanisation section includes the definitions and causes of urban population growth, and urbanisation circumstances across the world. Then, this section reviews the relationship between urbanisation and urban economic development. In order to build a connection between urbanisation and housing demand, this section also reviews the effect of China's urban housing on urbanisation and housing investment on urbanisation. The housing demand section includes a discussion and analysis of the distinction between housing demand and housing need, neoclassical consumption theory on housing demand, the nature of housing as a unique product and the key factors of housing demand. The densification section includes the relationship between urban compactness and housing densification, density and its measurements, and urban land-uses.

Chapter 4 presents the method designs for the three embedded units. The chapter includes the theoretical base of methods, model estimations for urbanisation and housing demand, GIS applications with spatial aggregation and data issues. The theoretical base discusses multiple regression and the Ordinary Least Squares (OLS) method as the analytic technique for urbanisation and housing demand and explains the housing density method with the selected measures. Then, the thesis discusses the process of model estimation for urbanisation and housing demand, respectively. The thesis also discusses GIS applications with spatial aggregation for investigating housing densification. The section of data issues involves data collections and data adjustments for each embedded unit.

Chapter 5 presents the analysis for urbanisation. Firstly, the chapter presents descriptive statistics and model results. It discusses each variable and how they influence urbanisation. Then, the chapter conducts a further analysis on migration as a potential key factor that is excluded in the models on the urbanisation of Shenyang. This section discusses the influence of the *hukou* system on migration, and it also shows the advantages of Shenyang that attract migrants. Furthermore, different types of housing investment are discussed. SOEs as the primary source body of state-owned enterprise investment (SEI) and shareholding company investment (SI) are further discussed, in

order to show the important role of SOEs in housing development.

Chapter 6 presents the analysis for housing demand. Firstly, the chapter presents the model results and explains the models. Then, the thesis discusses each variable within the models. The income discussion analyses the relationship between income and housing expenditure, in order to show the transformation of people's notions about purchasing a house. The housing price section discusses the effects of the housing reform on housing prices. The demographic section firstly discusses the influence of household size on housing demand, and then it extends to focus on marriage and sex ratio, which may influence housing demand. Moreover, the chapter explains commuting costs and residential expenditures respectively, revealing people's housing preferences in relation to distance. It finally explains people's thoughts about residential expenditures related to housing during housing development.

Chapter 7 presents the analysis for housing densification. The thesis displays housing density results in each spatial aggregation level, aiming to show the specific circumstances of housing densification and to compare densifications either between the urban and suburban areas or between different districts. Then, the chapter discusses urban land-uses, which explain the inevitability of housing densification. Furthermore, the chapter discusses housing vacancy in Shenyang and explains the key reasons at work.

Chapter 8 brings a conclusion to the thesis. Besides the conclusions for each topic, the chapter discusses the key findings and research limitations and raises policy recommendations considering migration, further housing development and environmental protection. Finally, the chapter presents the contributions of the thesis to the wider ongoing research debate in this field.

2. The Background of the Shenyang and Chinese Housing Markets

2.1. Chapter introduction

Based on the research design, this chapter aims to present an overview of the case-study area and an introduction to the urban system and housing market for China and Shenyang, in order to make readers aware of the conditions of the research area.

For the overview of the case-study area, Shenyang, firstly the chapter lists general information on Shenyang, including its geographic location, its population and its relationships with other important cities within Liaoning Province. Secondly, the chapter introduces the administrative division for the city of Shenyang with population densities. This not only helps to understand the central urban cores and suburban areas for the application of spatial aggregation in Chapter 5, but also aims to prove Shenyang's high-density living in the central urban cores. Thirdly, the chapter lists Shenyang's GDP in recent years, which helps to understand its economic development.

In order to gain an understanding of Chinese housing development, the chapter introduces neoliberalism[6] and its practices in China's economy after the 'opening-up'. According to the literature, neoliberalism with its unique features (such as pro-market, privatisation, etc) is believed to have boosted China's economy and reshaped the market (Harvey, 2005, He and Wu, 2009). The chapter provides a brief introduction to neoliberalism through its definitions and history, and then it explains how neoliberalism influences the Chinese economy and urban development, in order to make a transition to the later discussion of housing development.

For Chinese housing development, the chapter focuses on the market and the policy respectively. Based on the literature, the thesis divides the Chinese housing market development into four stages, in order to present the evolution of the housing market since the opening-up in 1978. Furthermore, the chapter also introduces an overview of Shenyang's housing development through three different phases, focusing on housing construction, the establishment of an affordable housing system and the property management of residential communities, with the relevant regulations issued.

[6] Discussing neoliberalism and its application to China's economy and urban development is helpful to understand Chinese housing development and housing reform. It is also helpful for readers to understand why China has experienced rapid economic growth since the 1980s.

2.2. The overview of Shenyang

Shenyang is the capital city of Liaoning Province and it is located in the centre of the province, in the northeast China. It is the largest city in the northeast of China (Figure 2.1). The geographic coordinates are between 122° 25′ 9″ E and 123° 4′ 24″ E, and between 41° 11′ 51″ N and 43° 2′ 13″ N. The total land area of Shenyang is 12,860 km^2, and the central urban land area is 1,460 km^2 (Shenyang Statistical Bureau, 2013). Shenyang consists of five central urban districts, four suburban districts, and four counties[7]. By the end of 2014, the total permanent resident population of the city was 8.28 million with 6.66 million in the urban population and 1.62 million in the rural population. Table 2.1 presents the population of each district. The total number of households is 2.63 million (Shenyang Statistical Bureau, 2015).

As Shenyang is located in the south of the northeast China and at the centre of Liaoning Province, it has an influential role in the economy. Important heavy industrial cities like Anshan (iron and steel city), Fushun (coal city), Panjin (petroleum city) and Dandong (textile city) are located within a 150km radius around Shenyang. Dalian Port, as the biggest port in the northeast of China, and other newly constructed ports like Yingkou Port and Jinzhou Port are no more than 400km away from Shenyang (Shenyang Statistical Bureau, 2013).

In 2010, Shenyang and its eight nearby cities were established as a comprehensive reform pilot zone by the State Council. It was called the Shenyang Economic Zone (Han et al., 2011). The zone covers 75,000 km^2 with a population of 23.6 million and the average urbanisation rate is 65 percent. The establishment of the zone shows a shift of Shenyang from an old industrial city to a comprehensive city with multiple functions (Han et al., 2011).

[7] According to *Shenyang Yearbook 2013*, Shenyang has nine districts and four municipal counties. According to *Shenyang Statistics Yearbook 2015*, the nine districts include: five central urban districts, located in the urban core; and four suburban districts, surrounding the urban core. In the Chinese administrative divisions, Shenyang, as the capital city of Liaoning Province, is classified in the prefectural level, which is the second level of administrative divisions.

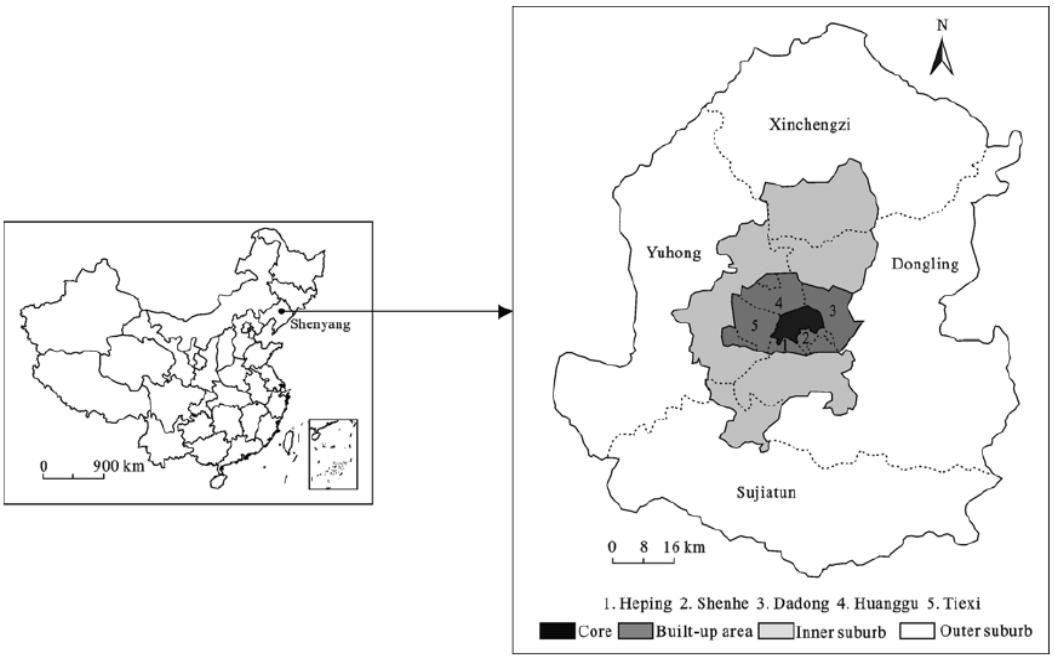

Figure 2.1 location and map of Shenyang

Source: Qin and Zhang, 2011

Table 2.1 Land area, population, and population density for each district of Shenyang

	Land area (km^2)	Population (thousand)	Population density (person/km^2)
Central urban districts			
Heping	59	645	10,952
Shenhe	60	716	11,961
Huanggu	66	817	12,360
Dadong	100	689	6,807
Tiexi	286	907	3,177
Suburban districts			
Sujiatun	782	428	546
Hunnan	734	324	455
Shenbeixin	884	320	362
Yuhong	499	435	893
Counties			
Liaozhong	1,645	532	320
Kangping	2,167	352	161
Faku	2,281	447	196
Xinmin	3,297	690	207

Source: Shenyang Statistical Bureau. 2015

Since the 1990s, Shenyang's economy has been developing at a rapid speed, resulting in increasing annual total GDP (Figure 2.2). By the end of 2014, the total GDP of Shenyang was 709.8 billion yuan. Compared to the year 2005 and 2013, the growth rates were 240 percent and 4.87 percent respectively. By the end of 2014, the GDP per capita of Shenyang was 85,816 yuan. Compared to the year 2005 and 2013, the growth rates were 205 percent and 4.31 percent respectively (Shenyang Statistical Bureau, 2015). In detail, the GDP of primary industry was 32.53 billion yuan by the end of 2014, with a growth rate of 1.15 percent compared to the year of 2013. The GDP of secondary industry and tertiary industry were 354.1 billion yuan and 323.2 billion yuan respectively by the end of 2014 (Figure 2.4). Compared to the year 2013, the growth rates were 3.7 percent and 6.63 percent respectively (Shenyang Statistical Bureau, 2015). The statistics show that Shenyang's economy relies mainly on its secondary industry and tertiary industry. The building industry is an important section of the secondary industry; in 2014, its output was 38.4 billion yuan, and its growth rate was 8.1 percent compared to the year 2013. In 2014, the complete investment in real estate was 197.5 billion yuan, including 141.6 billion yuan of completed investment in housing, accounting for 71 percent of total investment (Shenyang Statistical Bureau, 2015). The details of housing investment will be discussed in Chapter 3.

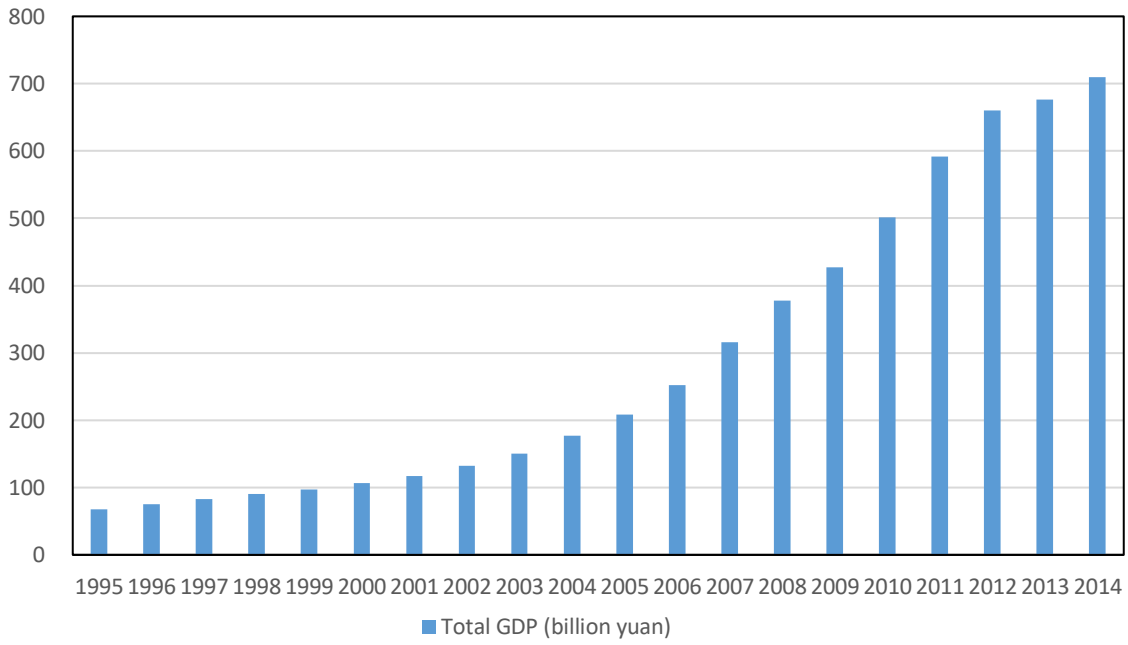

Figure 2.2 Total GDP of Shenyang from 1995 to 2014

Source: Shenyang Statistical Bureau, 2015

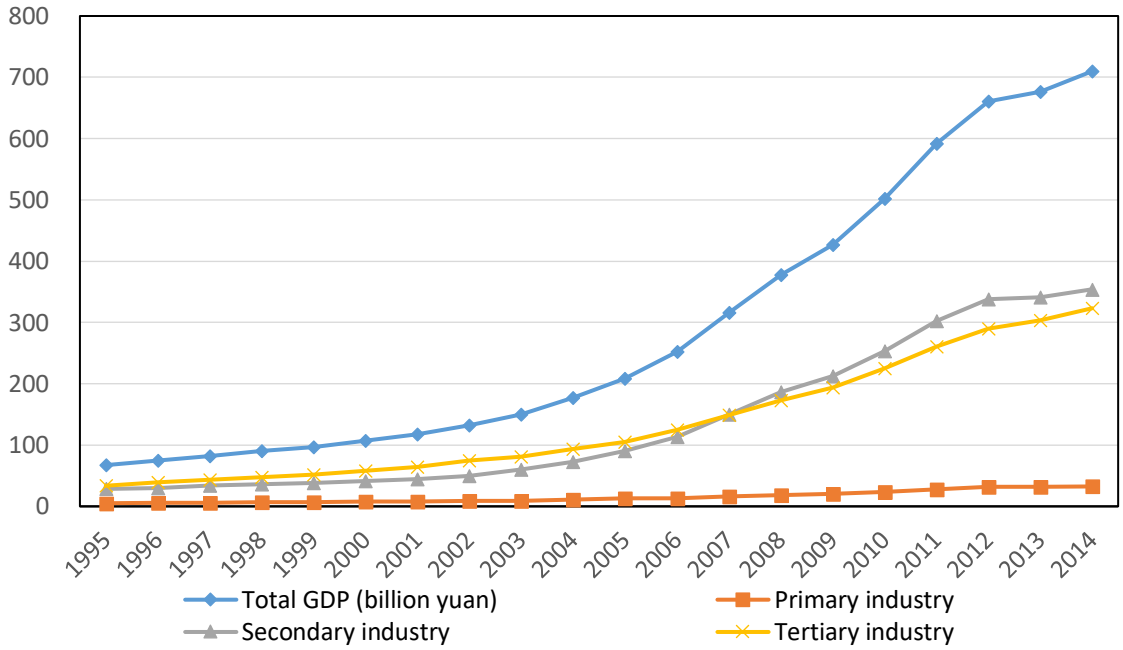

Figure 2.3 The total GDP and GDP of the primary, secondary and tertiary industry of Shenyang from 1995 to 2014

Source: Shenyang Statistical Bureau, 2015

2.3. Neoliberalism in Chinese urban development and housing reform

The milestone for economic development in China was the policy implementations of the opening-up, termed "Socialism with Chinese characteristics", led by Deng Xiaoping[8] in 1978, under which a series of market-oriented reforms was carried out in China (Zhen et al., 2008, Lardy, 2004, World Bank, 1992). The essence of the opening-up in China was the practice of neoliberalism, or "China's engagement with neoliberalism" and "neoliberalism with Chinese characteristics" (He and Wu, 2009, Weber, 2018, Harvey, 2005).

[8] The Chinese economic reform and opening-up was announced at the Third Plenary Session of the 11th Central Committee of the Chinese Communist Party in December, 1978. At the 4th National Congress of the Chinese Communist Party held in 1992, the idea of "developing a socialist market economy with Chinese characteristics" proposed by Deng Xiaoping was first designated as the leading strategy of the Chinese Communist Party.

'Neoliberalism[9]', a revival of 'liberalism[10]', argues for the desirability of a society organised around self-regulating markets, free as far as possible from social, economic and political intervention (Gregory et al., 2011, Thorsen and Lie, 2006). In the recent 'critical' literature, Harvey (2005, p.2) in his *A Brief History of Neoliberalism* emphasised that neoliberalism is 'a theory of political economic practices' rather than a 'complete political ideology' and gave a wide-ranging definition for the term, as follows:

> Neoliberalism is in the first instance a theory of political economic practices that proposes that human well-being can best be advanced by liberating individual by strong private property rights, free markets and free trade ….State interventions in markets (once created) must be kept to a bare minimum because, according to the theory, the state cannot possibly possess enough information to second-guess market signals (prices) and because powerful interest groups will inevitably distort and bias state interventions (particularly in democracies) for their own benefit.

Thorsen and Lie (2006, p.11-12) reviewed Harvey's definition of neoliberalism "not as the rejuvenation of liberalism in general, but as a distinctive economic theory which in recent has replaced a more mild-mannered 'embedded liberalism', i.e. Keynesian approaches to macroeconomic governance inspired by modern liberalism". They also considered that the definition by Harvey was not a continuation of liberalism 'proper' but something independent in the values and policies of liberalism. Then, Thorsen and Lie (2006, p.14) gave a definition of neoliberalism based on a more disinterested analysis of the phenomenon of neoliberalism and the conditions for politics, as follows:

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[9]Neoliberalism first appeared as a political ideology in Jacques Cros' doctoral thesis, resulting from a few efforts at reviving classical liberalism in the period immediately before and during World War II, by political theorists Wilhelm Ropke and Friedrich von Hayek. The term came into prominence in the 1980s, at a time which saw the collapse of socialist and communist projects. The main practices of neoliberalism include pushing economic deregulation and privatisation of state enterprises as promoted under Margaret Thatcher in the UK and Ronald Reagan in the USA, the opening of the economy to foreign investors in Chile, and the opening-up in China.

[10] Liberalism is a political and moral philosophy, with the view that individual freedom should be the basis of human life. In liberalism, human well-being is maximised when individuals are free to pursue their own interests without harming others. At the national level, liberalism includes classical liberalism and modern liberalism. Classical liberalism considers that the country ought to be minimal, which means that everything except armed forces, law enforcement and other 'non-excludable goods' ought to be left to the free dealings of its citizens, and the organisations they freely choose to establish and take part in. Modern liberalism considers that the country ought to become an active participant in the economy, with a pronounced tendency to regulate the market and to have the country supply essential goods and services to everyone. Therefore, modern liberalism is a profound revision of liberalism, especially of the economic aspect. Although both classical and modern liberalism refer to *laissez-faire* economic policies that lead to more freedom and real democracy, modern liberalism believes that the country must play an essential role in the economy to regulate the market.

"Neoliberalism is, as we see it, a loosely demarcated set of political beliefs which most prominently and prototypically include the conviction that the only legitimate purpose of the state is to safeguard individual, especially commercial, liberty, as well as strong private property rights. This conviction usually issues, in turn, in a belief that the state ought to be minimal or at least drastically reduced in a strength and size, and that any transgression by the state beyond its level as well, where a system of free markets and free trade ought to be implemented as well; the only acceptable reason for regulating international trade is to safeguard the same kind of commercial liberty and the same kinds of strong property rights which ought to be realised on a national level." By the definitions above, we see that neoliberalism is significant: a system of free markets and free trade at both a national and international scale. It can provide creative potential and entrepreneurial spirit, which is built into the spontaneous order of any human society and therefore leads to more individual liberty and well-being, and a more efficient allocation of resources (Thorsen and Lie, 2006).

Neoliberalism, with its ideas of free market competition at a global and national scale, drives all aspects of development and economic growth, especially for urban development, because cities have become increasingly important geographical targets and institutional laboratories for various neoliberal experiments, such as place-making, urban development corporations, public-private partnerships, new forms of local boosterism and property-led redevelopment (Brenner and Theodore, 2002, Smith, 2002). These new features of neoliberalism create *neoliberal urbanism* with drastic socio-economic and spatial changes (Brenner and Theodore, 2002). Among these changes, urban redevelopment with massive housing constructions is an important component of spatialised capital accumulation (He and Wu, 2009).

Neoliberalism, providing a free-competition market and state restrictions across national and global scales, does not only prevail in North America and Western Europe, but it also generates a massive influence on urban policies and practices in developing countries (Peck and Tickell, 2002). Moore (2004) described the post-cold war era of neoliberal globalisation as the 'Second Age of the Third World', and "its re-entry into the protracted process of primitive accumulation" as the identity of the Third World. In East Asia, for example Japan and Korea, the exploration of the spaces of neoliberalism demonstrates a process of state restriction in response to the influence of neoliberalism. China, the largest developing country in the world, has also been influenced by neoliberalism, and topics

such as "China's engagement with neoliberalism" and "neoliberalism with Chinese characteristics" focus on the interplay between capitalist globalisation and inherited institutional infrastructures in China (Harvey, 2005, He and Wu, 2009).

As the opening-up policy with market-oriented economic reforms[11] was implemented in 1978, the power of the market reshaped China's economy and its urban landscapes. The elements of neoliberalism, such as privatisation and commodification, have emerged and have fundamentally restructured "the regulatory-institutional architecture and urban spatial structure in China" (He and Wu, 2009, p.284). The most noticeable change was decentralisation, which shifted the process of decision making from central to local authorities (Brenner and Theodore, 2002, Perreault and Martin, 2005). This is considered to be the most important neoliberal shift in the reform (He and Wu, 2009). The most significant change with regard to applying decentralisation in the reform was the application of a new tax-sharing system, which aimed to cope with the trend of fiscal decline. The old revenue-sharing system was a highly redistributive system, transferring intergovernmental revenues to balance yielded revenue and permit local expenditure. As a result, industrial regions remitted high proportions of their revenues, and the other regions such as agricultural and natural resource-producing regions received large transfers. Under the new tax-sharing system, revenues were reassigned between the central and local governments, and the tax structure was simplified (Wong, 2000).

Furthermore, neoliberalism, with its two essential features of commodification and privatisation, played its role in creating a new mode of regulation within the process of neoliberal urbanisation in practice. This reduced the costs of providing public services and provided new sources of capital accumulation for the private sector (He and Wu, 2009). The most significant practice was urban land and housing market, which enabled the commodification of urban housing and the privatisation of public service provision. Within those neoliberal shifts and developments, the real estate industry has become an important sector for the economy, and it has promoted rapid urban development (He and Wu, 2005). Housing, as the main body of the real estate industry, has reformed the

[11] The economic reform with the opening-up policy was put into practice in 1978. A series of institutional reforms have been implemented in China, in order to make the transition from a central planned economy to a market-oriented economy. The economic reform had two tasks: first, to create new incentives at the sub-national level to increase efficiency and production; second, to transfer the development pressure confronted by the central government to the local authorities.

commodification of urban land and housing, and the privatisation of public service provision (He and Wu, 2009).

The next section will discuss the housing market development in China. Between 1966 and 1976, due to the Cultural Revolution, China experienced economic stagnancy and its urban areas began to take on a dilapidated appearance (Yeh and Wu, 1999). In order to implement a market-oriented economic system to save the destructive situation, the economic reform directed by the opening-up policy started in 1978 (Yeh and Wu, 1999). Therefore, the year of 1978 is commonly believed to be a milestone for Chinese economic development. The next section will focus on the housing market development and the relevant policies after 1978, which also helps to explain how elements of neoliberalism influenced the housing market and housing policies.

2.4. Housing market development of China

Housing is a significant industry for the Chinese economy, and the housing market has undergone constant changes (Deng et al., 2009). Before the opening-up, the old housing system in China was part of social welfare, and most houses were provided for free by the governments and SOEs. After the reform and opening-up, the real estate industry developed rapidly, and the housing market matured gradually. China's housing market development has experienced four stages since the opening-up in 1978 (Deng et al., 2011a), and the relevant housing policies are listed in the Appendix.

The first stage was from 1978 to 1988. Total housing investment increased from 29.5 billion yuan in 1981 to 118.7 billion yuan in 1988, among which urban housing investment increased from 14.9 billion yuan to 57.8 billion yuan (National Bureau of statistics of China, 2017). The figure implies that housing development was balanced in the rural and urban areas of China. During this stage, SOEs provided welfare housing for their staff, while some initial real estate companies emerged in the market. Most free houses were small and not big enough for the household's use, which deteriorated people's living conditions and developed into a housing shortage under this old housing system. Thus, housing reform was on the government agenda as soon as the government launched the economic reform in 1978 (Zhang, 2014b).

The second stage was from 1990 to 1995. During this period, China's economy entered into a new expanding development, and housing investment increased rapidly (Deng et

al., 2011a). The total housing investment increased from 116.4 billion yuan in 1990 to 473.6 billion yuan in 1995, among which the urban housing investment increased from 49.8 billion yuan to 327.8 billion yuan (National Bureau of statistics of China, 2017). These figures imply that housing development was concentrated in the urban areas of China. The real estate industry expanded as it entered into business activities related to land transactions (Zhang, 2014b). In 1994, another critical document *The Decision on Deeping the Urban Housing Reform* was issued; this provided a comprehensive framework for housing reform (Huang, 2004). On the supply side, the government aimed to build a multilayer housing provision system for different income groups. For example, middle and low-income households would purchase subsidised affordable housing through the Economic and Comfortable Housing programme (ECH)[12]. On the demand side, a dual housing finance system was established to combine social saving and private saving (Wang and Murie, 2000). Besides, homebuyers could choose subsidised mortgage loans through the Housing Provident Fund (HPF), which was a compulsory housing saving programme (Wang and Murie, 2000).

The third stage was a quick development stage from 1998 to 2002. During this period, due to the Asian Financial Crisis, China's exports reduced dramatically, and the economy showed signs of decline for the first time in the 1990s. In order to minimise the negative impacts of the crisis, the government sought to increase domestic demand and consumption. Thus, housing development, believed to generate demand in many other sectors and to create employment, did not fall back but attracted a massive amount of investment (Wang et al., 2012). During this period, total housing investment increased from 639.3 billion yuan in 1998 to 940.7 billion yuan in 2002, among which urban housing investment increased from 431.0 billion yuan to 724.8 billion yuan (National Bureau of statistics of China, 2017). The central government issued *The Notification from the State Council on Further Deeping the Reform of the Urban Housing System and*

[12] The affordable housing programme in China refers to the Economic and Comfortable Housing programme (ECH) – *jingji shiyong fang and anju projects.* The programme was introduced in 1994, and it aims to provide affordable housing by subsidizing commercial housing purchases or by offering low-rent public (social) housing to middle- and low-income families, supported by special government loans and free land allocations. In general, the central government sets policies and mandates with respect to affordable housing, and the local governments are responsible for construction, financing, and management for affordable housing. However, affordable housing programmes have not been implemented well in some areas, because local governments were more willing to develop commercial housing than social affordable housing. The fundamental reason for this was that, for commercial housing development, developers paid huge fees in land acquisitions and various charges. Those fees were collected by the local government and contributed to the main sources of local government revenues.

Accelerating Housing Construction in 1998, which marked an end to welfare housing provision (Huang, 2004). The SOEs and other work units were prohibited from building or buying housing for their staff. Instead, they had to convert the housing fund into monetary subsidies. Then the staff could buy houses on the market (Wang and Murie, 2000). This reform caused a huge housing demand for more housing space with a higher living quality, which provided more development opportunities for the housing market. However, at this stage, China's housing market was not as active as the market in Western developed countries, and housing policies were under-practised. For example, although the SOEs no longer built housing directly for their staff, they were involved in the staff's housing consumption, via cash-based housing subsidies and the Housing Provident Fund (HPF) programme (Zhang, 2014b).

The fourth stage was from 2002 to the present. During this period, the housing industry has been adjusted, and the housing market has become more active. The total housing investment increased from 940.7 billion yuan in 2002 to 8,061.5 billion yuan in 2014, among which the urban housing investment increased from 724.8 billion yuan to 7,288.8 billion yuan. Urban housing investment therefore accounted for approximately 90 percent of the total figure, evidence of rapid urbanisation and a higher demand for housing. In 2002, the Ministry of Land and Resources issued a competitive bidding, auction and listing-for-sale transfer policy for the right to use state-owned land as profit-oriented land, which standardised the land market. The aim of this policy was to reduce land speculation from some enterprises. Meanwhile, some large real estate enterprises[13] with powerful financial support started a large-scale expansion, which triggered a new wave of real estate investment booms (Yi, 2018). In 2003, *An Announcement on Promoting Persistent and Healthy Development of the Real Estate Market* was issued by the State Council, which indicated that the real estate industry was considered to be a pillar of the national economy. In the same year, *The Notice on Promoting the Continuous and Healthy Development of the Real Estate Markets* was issued by the central government. The policy did not only aim to solve the imbalance of housing demand and supply in some areas and

[13] Between 2000 and 2008, some large real estate enterprises expanded their businesses to the national scale. These included: Vanke, Poly, Sunac, Longfor, China Overseas, China Resources Land, Evergrande, and Country Garden. The business expansion of those real estate enterprises mainly focused on the first-tier and second-tier cities. Enterprises such as Evergrande and Country Garden expanded their development to the third-tier and fourth-tier cities. Besides the expansion of housing development, they also opened related businesses such as building design and property management.

to control the rapid price increases and investment, but it also confirmed to improve the affordable housing system (Ma, 2017). During this stage, developers pushed up housing prices to maintain profits (Wang et al., 2012). As a result, the housing market bubble with increasing housing prices emerged in many areas of China, especially in some large cities (Zhang, 2014b). In 2005, in order to control the housing market bubble, *The Suggestions on Works of Stabilising Housing Price* was issued by the State Council. Besides aiming to stabilise higher housing prices, this policy also announced to ensure sufficient land supply and increase investment for affordable housing construction (Wang et al., 2012). However, in order to pursue higher profits, some speculative activities have occurred in the housing market since 2007, such as '*Quanqian*[14]' and '*Quandi*[15]'. Wang et al. (2012) have also indicated other factors that caused the inflation of housing prices: the relatively stable share prices on the new stock market; low interest rates for savings; the expectation of the increased value of the Chinese currency; and migrations moving into large and coastal cities. Finally, due to China's admission into the World Trade Organisation, international companies with highly paid employees arrived, which indirectly boosted housing prices.

2.5. The overview of Shenyang's housing development

This section focuses on housing development in Shenyang after 1995[16], when the nationwide housing reform was at the trial stage. The housing development in Shenyang during this period can be divided into four stages, and this section focuses on housing construction, the establishment of the affordable housing system and the property management of residential communities.

The first stage was between 1995 and 1997. Due to the Asian Financial Crisis and the domestic housing reform, housing investment in Shenyang decreased from 2.21 billion yuan in 1995 to 1.77 billion yuan in 1997. Meanwhile, during the same period, the urban

[14] '*Quanqian*' refers to developers using different ways to have financing from the market, such as financing from the stock market.

[15] '*Quandi*' refers to after having financing developers buy and hold land as much as possible, in order to develop them when the price goes higher.

[16] In order to match the research period for urbanisation in Chapter 5 and the housing demand in Chapter 6, the overview of Shenyang's housing development in this section starts from 1995. Another reason for this time selection is the lack of existing academic literature on Shenyang's housing development and the limited access to *Shenyang Yearbooks* before 1995.

housing space per capita was increasing from 6.81 m^2 to 7.51 m^2 (Shenyang Statistical Bureau, 1998).

In this period, the housing development in Shenyang focused on establishing the system of HPF. In order to establish a comprehensive HPF system, the local government issued *The Opinions on Strengthening the Housing Provident Fund* in 1996. This document aimed to build a link between the HPF system and employees' salaries, which established a control mechanism for the HPF system for Shenyang. Plus, the document also delegated two major banks (China Construction Bank and Industrial, and Industrial and Commercial Bank of China) for the deposit and loan business of the HPF system (Shenyang Statistical Bureau, 1996). Also, in order to coordinate the nationwide housing reform, the City Housing Reform Leading Group issued *The Notification on Termination of Welfare Housing Allocation System* in the same year. This document aimed to shift the existing public housing stock to the housing market and to sell those housing stocks at market prices (Shenyang Statistical Bureau, 1996). In 1996, 385 million m^2 of public housing were sold in Shenyang (Shenyang Statistical Bureau, 1996). In the same year, Shenyang started to implement an affordable housing programme following the guidance from the central government and issued *The Scheme of Affordable Housing Programme Implementation for Shenyang*. The policy aimed to gradually solve the housing shortage issue for middle- and low-income people in the next six years. During this period, the affordable housing programme has been developing fast. In 1995, the affordable housing space constructed was 153,000 m^2 with 0.32 billion yuan of investment. In 1997, the affordable housing space constructed increased up to 880,000 m^2 with 0.95 billion yuan of investment. However, some issues arose during this period. Some residential housing constructions were at a standstill due to funding shortages, which resulted in a shortage of further housing investment. Some over-development appeared in some areas because of less accurate housing market forecasts. Substandard housing quality, insufficient housing facilities and poor property management occurred during this period. Furthermore, the hoarding of housing stock and the affordability of housing prices were two potential issues for the coming years (Shenyang Statistical Bureau, 1997).

The second stage was between 1998 and 2002. Housing investment increased from 2.01 billion yuan in 1998 to 8.31 billion yuan in 2002, which was viewed as a market recovery from the Asian Financial Crisis (Shenyang Statistical Bureau, 2015).

Following *The Notification from the State Council on Further Deepening the Reform of the Urban Housing System and Accelerating Housing Construction* by the central government, the Shenyang municipal government issued some documents to reinforce the newly built housing system. Those documents included *The Regulatory Measures on the Sale of Commercial housing for Shenyang*, *The Notice on the Issues Related to Promoting the Real Estate Market* and *The Schemes on Public Housing Use Rights Transfer for Shenyang*. After trialling the HPF for several years, the system was fully implemented in Shenyang in 1999. The rents of public housing increased from 1.20 yuan/m^2 to 1.60 yuan/m^2. There was significant progress in the sale of public housing. The cost price of public housing increased from 880 yuan/m^2 to 924 yuan/m^2. In 1998, the total sales of public housing totalled 500 million m^2 (Shenyang Statistical Bureau, 1998). In 1999, the HPF system expanded to cover private and individual businesses. By the end of 1999, the number of individual HPF accounts had increased to 1.13 million (Shenyang Statistical Bureau, 1999). In 2000, housing constructions and housing sales reached the first peak in history, achieving 6.03 billion yuan of housing investment and 8.46 million m^2 of housing construction (Shenyang Statistical Bureau, 2000). For the housing reform, in order to keep selling existing public housing in accordance with the central government's instructions, Shenyang municipal government issued *The Notice on Housing Prices and Sale Policies of the Public Housing* in 2001. Under this document, 5.58 million m^2 of public housing were sold in 2001 (Shenyang Statistical Bureau, 2001). In 2002, the government issued *The Notice on Further Promoting Public Housing Reform*. This policy supplemented and extended the 2001 public housing policy. In this policy, the price of public housing was regulated from 950 yuan/m^2 to 990 yuan/m^2. During this stage, the affordable housing programme has been steadily implemented. In 1998, the affordable housing space constructed was 590,000 m^2 with 1.1 billion yuan of investment. Entering the 21st century, Shenyang's affordable housing construction has been slowed down and shifted to focus on Low-rent Housing programme (*lianzu fang*) for low-income people. In 2002, the investment on low-cost rental housing was 59 million yuan with 45,000 m^2 of housing space. During this period, the living environment of residential communities and the quality of property management improved significantly (Shenyang Statistical Bureau, 2002). One hundred and twenty three residential communities achieved the standardised criteria, and 517 residential communities started property management operated by professional property management companies (Shenyang Statistical Bureau, 2002). In 2000, the local government issued *The Schemes on*

Comprehensive Management of Residential Communities and Staff Dormitories, and 58 million m^2 of green space were planted in this year, improving the residential environment for the citizens (Shenyang Statistical Bureau, 2001).

The third stage started in 2003. In this period, the real estate business developed rapidly. Housing development expanded gradually, and both demand and supply in the housing market showed strong growth. For housing investment to housing construction and sales, it was considered as the most significant period of all time. Housing investment increased from 13.84 billion yuan in 2003 to 80.21 billion yuan in 2009 and housing construction increased from 14.01 million m^2 in 2003 to 68.47 million m^2 in 2009. Housing sales increased from 4.09 million m^2 in 2003 to 15.32 million m^2 in 2009 (Shenyang Statistical Bureau, 2015).

Following *The Regulations on Property Management* issued by the central government in 2003, nearly 90 percent of residential communities in Shenyang carried out property management by professional management companies; in the past, developers had been responsible for property management. Meanwhile, local government also issued *The Pilot Schemes on the Qualification of Property Management Companies*, in order to standardise Shenyang's property management market. In 2004, the affordable housing system was initially established, and the local government issued *The Measures for the Affordable Housing for Urban Households with the Lowest Income* and *The Administrative Measures of the Affordable Housing Subsidies for Urban Households with the Lowest Income*. In the same year, the local government invested in the construction of 0.4 million m^2 of affordable housing. In 2005, the Shenyang Municipal Bureau of Real Estate issued *The Notification on Strengthening the Management of Property ownerships*, which clarified and regulated the certificated authority of property ownership registration. In the same year, the bureau issued *The Notification on the Establishment of Electronic Archives of Property Ownerships*, which strengthened the framework of the property ownership system. In 2008, following *The Suggestions on Solving Difficulties of Urban Low-income Families in Housing* issued by the central government, the local government successively issued *The Plans (2008-2010) on Solving Difficulties of Urban Low-income Families in Housing for Shenyang* and *The Implementation Plans (2008) on Solving Difficulties of Urban Low-income Families in Housing for Shenyang*. In the same year, 1.07 million m^2 of affordable housing was completed, helping around 16,000 urban low-income families into housing.

The fourth stage started in 2010, and the housing market in Shenyang entered a steady growth period. Housing investment increased from 107.5 billion yuan in 2010 to 141.6 billion yuan in 2014. New housing construction rose from 88.58 million m^2 in 2010 to 9.93 million m^2 in 2014 and house sales increased from 15.16 million m^2 in 2003 to 13.42 million m^2 in 2014 (Shenyang Statistical Bureau, 2015).

In order to regulate and promote property transactions, the local government issued *The Notice on Record Inquiries of Family Housing Registration* in 2010. This document helped financial institutions to implement the mortgage standards for second properties for families. In 2013, the Inquiry System of Family Housing Information for Shenyang was established, which ensured the safety and accuracy of information enquiries. The Low-rent Housing programme of affordable housing was improved during this period. The local government issued *The Implementation Details on Low-rent Housing Guarantee for Shenyang* in 2010, which unified the application and approval standards of low-rent housing guarantees. In the same year, around 34,100 households solved their housing difficulties through the low-rent housing programmes. In 2014, the Shenyang Municipal Bureau of Real Estate issued *The Supplementary Notice on Certificate Transfer of Property Ownership of Affordable Housing*, which formulated the conditions and orders for ownership certificate transfer. In 2010, *The Regulations of Property Management for Shenyang* was drafted, and officially became a legislative item in 2011. This document added a separate article for property management for old housing, which clarified the management responsibilities for different levels of local government and property management companies.

Following central government on the restriction of housing purchases, Shenyang's government started to implement this restriction with *The Notice on Issues Related to Housing Purchase Restrictions* in March 2011 (Shenyang Statistical Bureau, 2011). The policy validated the restriction of housing purchases within the second loop of the urban area of Shenyang: residents with the local *hukou* registration who already owned a house, or residents without the local *hukou* registration who could provide a certification of taxation or social insurance for more than one year, could purchase one dwelling. Residents with the local *hukou* registration who already owned more than two houses, or residents without the local *hukou* registration who owned more than one house and could not provide a certification of taxation or social insurance for more than one year, could not purchase a house within the second loop of the city.

In 2014, the housing market in Shenyang experienced a recession. The total housing investment in that year was 197.6 billion yuan, a drop of 9.5 percent compared to the year 2013. The taxation on real estate and the total floor area of housing sold also showed drops of 20.6 percent and 17.2 percent respectively, compared to the year 2013 (Shenyang Statistical Bureau, 2014). In order to activate the market and boost purchasing power, the municipal government issued *The Notice of Releasing the Purchase Restriction of Housing* in September 2014. The policy document reduced the housing purchase restrictions for residents with and without the local *hukou* registration: for residents with the local *hukou* registration, enquiry records of housing status[17] were no longer required; and for residents without the local *hukou* registration, certifications of taxation or social insurance were no longer required (Shenyang Statistical Bureau, 2014).

2.6. Chapter summary

This chapter firstly provides a background review of the case-study area, Shenyang, including information on the city and its economic status. The economic performance of Shenyang proves its socio-economic significance to both Liaoning Province and the northeast China. The overview also explains through statistics that Shenyang's economy relies mainly on secondary and tertiary industries. Considering that Shenyang is undergoing a transformation from an old industrial city to a comprehensive-functional city, it is believed that the real estate industry will play a significant role in both the economy and urban development of Shenyang. Therefore, housing, as the most important part of real estate, is worth researching in Shenyang.

To understand better Chinese housing development, this chapter then discusses neoliberalism. Neoliberalism is 'a theory of political economic practices' rather than a 'complete political ideology', involving commodification and privatisation as two essential elements. In relation to the Chinese context, the practices of neoliberalism were reflected in two main aspects after the opening-up in 1978: reshaping the economic system with the aim of establishing a market-oriented economy; and decentralising the power of decision making, shifting it from the central government to local authorities. For Chinese housing development, the greatest contribution of neoliberalism was the

[17] Enquiry records of housing status show how many dwellings a resident owns.

housing reform, which not only abolished the welfare housing provision system but also established a tradable housing market based on a dual housing provision system.

This chapter then discusses the Chinese housing market and the development in housing policy, respectively. The discussion on the Chinese housing market told the story of market development in four time phases, showing the changes in the market due to the housing reform. There was a rapid development in overall investment figures. The chapter also explained the causes of the increasing housing demand, which led to overinflated housing prices in some areas.

Finally, the chapter reviews Shenyang's housing development over four time phases. With the investment statistics and the relevant housing policies, it is concluded that Shenyang's housing market has been developing rapidly. The HPF system in Shenyang was established and improved by the municipal government's policy support, which was directed by the instructions of central government. This process also proves that the decentralisation of decision-making power, as a feature of neoliberalism, played a role in Shenyang's housing reform. The affordable housing programme was improved through time, shifting from affordable housing construction to low-rent housing provision, in order to help low-income people to afford housing. The sale of public housing proceeded smoothly, and the living conditions for the residents improved, as well as property management. As a result of the housing reform, Shenyang's housing market has improved to be more regulated and competitive with supervisions. However, some housing issues, such as hoarding housing stocks and rapidly increasing housing prices, emerged.

This chapter provides a background introduction to the thesis, which introduces readers to the three embedded units of the case study. The next chapter will review the existing literature on urbanisation, housing demand and housing densification.

3. Literature Review

3.1. Chapter introduction

Undertaking a literature review is an essential part for all research disciplines and all research projects, it is considered as a proper research methodology component for social science research (Tranfield et al., 2003, Saur-Amaral, 2011). There are two main reasons that consider literature review as a research methodology: first, when reading literature, the researcher describes previous research to map and assess the research area to motivate the study aim and justify the research questions, which is a beginning step of all research projects. For example, to start a research study, the researcher uses a literature review to realise what has been found and the key definitions for the research topic; second, for a number of research questions, a literature review may be the best methodological tool to provide answers. For example, literature review is useful when the researcher wants to evaluate a theory or an evidence in a certain area or to examine the validity of a certain theory (Snyder, 2019). Furthermore, literature review is useful when the research aim is to provide an overview of a certain issues or a research problem, in order to evaluate the state of knowledge, create research agendas, and to identify research gaps on a particular topic (Snyder, 2019).

Saur-Amaral (2011) gave a proposal on how to do a literature review from a methodological perspective for social science research, including four steps: 1. Plan, which defines the research topic and plans the effective search by reading literatures; 2. Do, which searches for relevant information sources and applies filters to ensure that literature review results are according to the plan; 3. Check, which checks coherence of results with topics; 4, Report, which produces descriptive or thematical reports. The four steps of doing a literature review is considered as a research process, from defining research topics to presenting results. The main difference of literature review as a method compared to other research method is that literature review is based on the existing results and analyses. Therefore, it provides an overview of a research problem and answers research questions in a broad perspective (Snyder, 2019).

Linking to this thesis, considering literature review as a proper research methodology, some research objectives can be achieved by a literature review. **Chapter 1.3** lists detailed research questions and related objectives for the three embedded topics (Table 1.1, Table 1.2, Table 1.3). Firstly, for the urbanisation unit, **RO1** explores urbanisation including its definition and causes and **RO2** identifies the relationship between urbanisation and urban

economic development. These two research objectives aim to provide an overview on urbanisation and urban economic development as a preparation of using urban economic method to investigate Shenyang's urbanisation, and they will be achieved by the literature reviews. Secondly, for the housing demand unit, **RO1** distinguishes housing need and housing demand and **RO2** studies housing demand models and the factors that influence housing demand. These two research objectives aim to present an overall perspective on housing demand and its influenced factors as a preparation of using housing demand model to test Shenyang's housing demand, and they will also be achieved through the literature reviews. Finally, for the housing densification unit, **RO1** studies the relationship between housing densification and urban compactness and **RO2** distinguishes different measures of housing density. These two research objectives aim to define housing densification and urban compactness in general and to prepare to select appropriate density measures for densification analysis and they will be addressed through the literature reviews. This chapter will present a comprehensive review of the existing literature on urbanisation, housing demand and housing densification, in order to provide theoretical context and achieve the relevant research objectives for the thesis.

3.2. Urbanisation

This section will review and discuss urbanisation. To understand urbanisation comprehensively, firstly, this section will clarify the definitions of urbanisation in demographic, economic and social-cultural aspects and then will discuss urbanisation process. Secondly, the section will discuss the positive impacts that urbanisation can bring to urban development and people's lives. Finally, the thesis will review the main causes of urbanisation with a particular focus on migration caused by economic growth.

3.2.1. Definition and process of urbanisation

Friedmann (2002) in his book *The Prospect of Cities* discusses definitions of urbanisation in three aspects: demographic, economic and socio-cultural. Firstly, from the demographic aspect, as the most common use of the term, urbanisation refers to "the increasing concentration of people (relative to a base population) in urban style settlements at densities that are higher than in the areas surrounding them" (Friedmann, 2002, p.3). Secondly, from the economic aspect, urbanisation refers to "economic

activities that we normally associate with cities" (Friedmann, 2002, p.4). Compared to these activities in cities, other activities occur in rural areas, such as agriculture, forestry, fishing and mining, and these are also involved in urban forms of capitalisation and organisation. As cities grow and expand, urban borders and rural areas are occupied gradually. The original rural life partly shifts to urban activities, such as having a vacation home with highways and supermarkets nearby. Through this process, "residual" rural activities are ultimately erased by economic urbanisation (Friedmann, 2002, p.4). Thirdly, from the socio-cultural aspect, urbanisation refers to "participation in urban ways of life" (Friedmann, 2002, p.5). Friedmann also indicates that "socio-cultural urbanisation is a dimension that, like the economic, is no longer exclusively associated with city as a built environment" (Friedmann, 2002, p.5). Linking to this thesis, to quantify urbanisation in a certain period and then to model urbanisation with its influencing factors, demographic urbanisation is suitable. Thus, urbanisation rate (or the level of urbanisation) will be investigated in this thesis, which is defined as the percentage of a population that lives in urban areas.

Urbanisation is not only a condition that is quantified at a time point, but it is also a process occurring over time. The process here mainly refers to migration from rural areas to urban areas, absolute population growth in urban areas (urban growth) (United Nations, 2015). The process of urbanisation is complex, and it is driven by a series of interrelated changes, including economic, demographic, political, cultural, social, technological and environmental changes (Knox and Pinch, 2014, McCarthy and Knox, 2005). American urban geographer Ray M. Northam (1979) researched the urbanisation of countries over the world and proposed the Logistic Curve. He classified the urbanisation process into three levels: at the first level, the urbanisation rate is below 30 percent, and the process is slow; at the second level, the urbanisation rate is between 30 percent and 70 percent and the process is rapid; and at the third level, the urbanisation rate is between 70 percent and 90 percent and it will keep stable because of the strong economy. The outcomes of urbanisation can bring changes to urban systems, land-uses, built environments and townscape, social ecology, and urbanism (Knox and Pinch, 2014). Some of these outcomes will generate social problems that may cause political conflicts. Subsequently, government policies, such as legal changes, urban planning and management will seek to address those problems (Knox and Pinch, 2014, McCarthy and Knox, 2005). The framework of the urbanisation process is illustrated below (Figure 3.1):

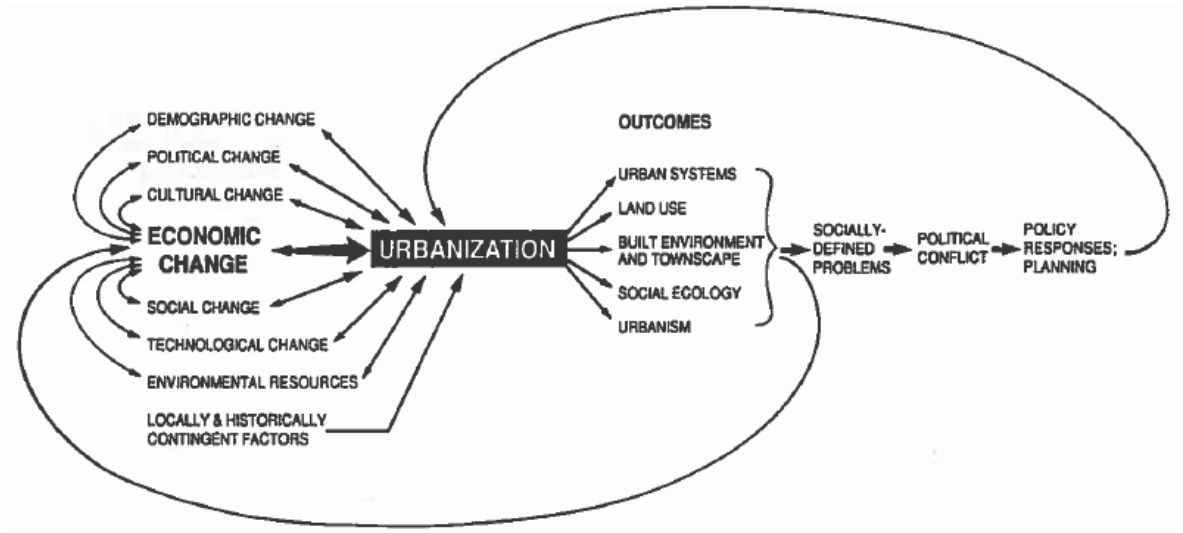


Figure 3.1 Framework of urbanisation as a process

Source: Knox and Pinch, 2014

3.2.2. Causes and positive factors of urbanisation

According to the definition, urbanisation is quantified by the percentage of the urban population, meaning that the urbanisation process can be seen as a process that increases the urban population. Drakakis-Smith (2012) indicates two leading causes of urban population growth: natural growth and migration to cities.

Firstly, natural growth of the urban population refers to the difference between the births and deaths in the population. Drakakis-Smith (2012) reported that around half of urban population growth was a result of a natural increase in the population of developing countries. The main reason of this natural growth was a sharp decline in mortality, particularly in infant mortality, which was a result of the accumulation of knowledge and skills in various fields of medicine, hygiene and nutrition. Meanwhile, fertility remained high, affected by a complex mix of biological, social and economic factors.

Secondly, migration is another cause that triggers an urban population to increase. Drakakis-Smith (2012) stated that migratory movements of a population were usually the result of an increase in population pressure on resources. Migration could occur in a variety of situations and it does not have a direct relationship with either population densities or the size of a resource base. Drakakis-Smith also indicated that in most

developing countries, population pressure became intense in the agricultural sector where natural growth had exceeded the productive requirements and the capacity of the land; this caused population shifts to other regions where a labour force was needed. Apart from those regions, large cities with higher economic growth and better employment opportunities were the principal attraction, attracting more migrants than small cities. Mehmet (2014) indicated that migration was primarily the consequence of both the absolute and relative poverty of rural areas in comparison to the cities, and that this could be explained by urban bias in economic policies.

There are numerous positive factors associated with urbanisation. Big cities are often viewed as dynamic and are considered to be developing centres for education, government, modern industry and production, financial and business services, as well as both internal and international trade (Bilsborrow, 1998). Arguably, that is the main reason why urban areas are much more efficient and competitive than rural areas in terms of economic growth, production and levels of incomes (Bilsborrow, 1998). A large number of people who choose to live in urban areas generally experience stronger and more stable economic situations and also longer life expectancy (Bilsborrow, 1998, Brookfield and Byron, 1993). For example, the life expectancy on average in Chinese urban areas is 75.21 years compared to 69.55 years in rural areas, according to the 2000 Chinese census (Li and Dorsten, 2010).

Furthermore, favourable living conditions are another positive factor caused by urbanisation. The numerous disparities in living conditions between urban areas and rural areas are reflected in the availability of safe drinking water and food, sufficient electricity, sanitation, education and medical security, entertainment, employment, and knowledge and information. These disparities can also be found among different income level groups. Across the whole world, the extent of poverty in urban areas is much lower than in rural areas, and the Multidimensional Poverty Index (MPI)[18] showed that 85 percent of the poor lived in rural areas across 105 countries in 2014 (Alkire et al., 2014). Generally speaking, if the level of urbanisation is high, the level of absolute poverty is low.

[18] The Multidimensional Poverty Index (MPI), published for the first time in 2010, identifies deprivations and shows the number of people who are multi-dimensionally poor and the number of deprivations with which poor households typically contend with. The MPI can be used in national levels using indicators and weights that describe poverty for regions or countries.

3.2.3. Urbanisation and sustainability

Urbanisation has brought challenges to urban sustainability in rapidly rising large cities, and the relationship between urbanisation and sustainability has been focused by numerous studies (Subramanian, 2007, Pugh, 2014, Zeng et al., 2016). According to the definition, sustainability is defined as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Robinson, 2004, p.369). The concept of sustainability has been interpreted in terms of three dimensions: environmental, social, and economic. This section will discuss the relationship between urbanisation and sustainability in each dimension.

Firstly, in an environmental sense, fast urbanisation with widespread urban expansion has brought enormous strain on ecological systems. Buildings, especially housing, and highways have sprawled rapidly with occupying cropland and forest in rural areas, and other lands with high ecological values in urban areas. In this case, although the urban landscape has been transformed into a manageable pattern in terms of its connectivity and compactness, the ecological habitat has been challenged and affected due to rapid urbanisation process (Zeng et al., 2016). In recent years, environmental sustainability has been paid much attention in many large cities, because high-density living due to fast urbanisation has brought challenges to environment, such as increasing pollutions and emissions, and decreasing public and open space (Robinson, 2004).

Secondly, in a social sense, sustainability is a process or framework that promotes people's wellbeing within an organisation while also supports the ability of future generations to maintain a healthy community (Robinson, 2004). It focuses on mitigating social inequity that is associated with issues such as social welfare for rural migrants, weak social ties in the urban setting with increasing rural-urban migration (Li et al., 2012b). In its initial period, urbanization positively influences the social aspects, including social mobilisation, political participation, education. However, these effects can become negative when urbanisation goes beyond the carrying capacity of the city (Shen et al., 2012).

Thirdly, in an economic sense, sustainability is described as the need to maintain a permanent income for humankind, generated from non-declining capital stocks (Spangenberg, 2005). According to the concept of sustainability that current decisions

should not damage the prospects for maintaining or improving living standards in the future, it implies that economic system should be managed so that the greatest amount of income can be consumed in the current period without reducing prospects for consumption in the future (Anand and Sen, 2000). Linking to urban development, economic sustainability focuses on the economic balance, which mainly refers to a holistic framework for industrial development in different sectors. A number of developing countries have experienced rapid industrialization and urbanization. In recent years, the service sector, which requires a variety of manual labour, has rapidly become the leading sector in the industrial structure of many countries. Under this industrial transformation, the requirements for natural resources and energy usage have expanded, thereby threatening the carrying capacity in certain areas. Consequently, economic balance is important to achieving the harmonious development between human activities and natural environment.

3.3. Urbanisation, urban economic development and housing

This section will review urban economic development and housing development in urban economics, in order to build link between urbanisation and housing. Firstly, this section will discuss the relationship between urbanisation and urban economic development. Secondly, it will introduce and discuss two important measures of economic development including GDP and employment share. Finally, in order to connect urbanisation and housing, this section will review housing investment and its impacts on urbanisation.

3.3.1. Urbanisation and urban economic development

Urbanisation is a natural and inevitable consequence of economic development in both developed and developing countries, and urban economic development involves a massive shift of labour and other inputs from rural areas to urban areas (Zhang, 2002, Mills et al., 1986, Henderson, 2003, Davis and Henderson, 2003). To further understand the relationship between urbanisation and urban economic growth, the thesis will discuss both sides of demand and supply to explain the shift of labour and other inputs from rural areas to urban areas, resulting in economic growth and then the increasing urbanisation.

Firstly, on the demand side, it is well known that food has accounted for a large share of income spent at low-income levels for more than a century. However, with economic

growth, the share spent on food declines due to the increase in income, while the amount spent on industrial products and services increases. This process is known as Engel's Law (Engel, 1857) and it explains low-income elasticities of food demand and high-income elasticities of industrial products and services. The result of this process is increased returns on labour and other inputs in industrial products and services compared to those in agriculture, and this induces the labour force and other inputs to move from the agricultural sector into industrial and service sectors, resulting in expanding economic scales in urban areas and then urban economic growth (Mills et al., 1986, Williamson, 1988). Secondly, on the supply side, the costs of industrial products may decline compared to those of agricultural products, and this may also result in a price decrease for industrial products. The innovation of techniques may develop faster in industry than in agriculture. Moreover, capital accumulation and economic scales may reduce manufacturing costs and prices for industry compared to agriculture. Finally, an industrial labour force with a high level of education may receive more benefit than those working in agriculture, and this will trigger a release of the labour force from agriculture to manufacturing and services. Then, with support of more labour force and investment, it will result in larger economic scales in urban areas and then urban economic growth (Bertinelli and Strobl, 2007). Furthermore, the effect of the supply side has more international considerations due to rapid globalisation. Most industrial products are tradable, and due to globalisation, most services can be tradable as well (Chen et al., 2014). If the economy has no barriers to access to the rest of the world, cost reductions will result in output increases, employment increases and price reductions. The whole processes will cause huge labour inflows (Mills et al., 1986, Chen et al., 2014, Bertinelli and Strobl, 2007). In conclusion, economic development causes a shift of labour force from agriculture to industry and services because demand rises and costs decline in industry and services relative to agriculture.

There is a large body of literature on urbanisation and economic development. Henderson (2003) worked on the urbanisation process and economic growth, and he concluded that in recent decades, rapid urbanisation has often occurred in the face of low or negative economic growth, and urbanisation was a transitory phenomenon as many countries are now fully urbanised. Mills et al. (1986) worked on Indian urban development, and besides testing and explaining historical Indian urbanisation, the authors concluded that future urbanisation depends on the growth of industry and other predominant urban factors. Zhang (2002) worked on China's urbanisation, and besides testing GDP and agricultural

employment as two drivers of national and regional urbanisation, he investigated how foreign direct investment could influence urbanisation in China.

3.3.2. The impact of measures of economic development on urbanisation

As mentioned in the previous section, urbanisation has a strong link with economic development, which economic growth advances productivity and expands economic scales, providing more opportunities for the agricultural labour force to work in industry and services, then resulting in increases of urbanisation. Therefore, to select appropriate economic measures and how those measures influence urbanisation are the next topics of discussion. Many researchers have chosen particular indices of development to estimate the relationships between urbanisation and economic development. These statistical analyses, based on regression, yield quantitative estimates of the significance of several variables, and estimate how closely the targeted case follows the typical pattern (Mills, 1972, Mills et al., 1986, Henderson, 2000, Henderson, 2003, Davis and Henderson, 2003).

Firstly, the most obvious measure of economic development with regard to urbanisation is GDP per capita, and a huge body of literature shows that GDP per capita is the most accepted measure to determine the economic performance of a whole country or region in a certain period of time (Mills et al., 1986, Henderson, 1991, Henderson, 2000, Davis and Henderson, 2003, Zhou, 1982). Economic base theory shows that industrial output is sold outside the urban area in which it is produced, it influences but is not influenced by the population of the urban area (Mills et al., 1986). This argument makes GDP per capita of industrial output as a desirable factor that influences urbanization. In addition, there are many researches that GDP per capita influences on urbanization level. Annez and Buckley (2009) indicated that there was a co-relationship between urbanisation and GDP per capita: the higher the urbanisation level, the higher the GDP per capita. This phenomenon was more evident for countries that had a GDP per capita less than USD 10,000. Zhang (2002) tested GDP per capita as the independent variable for China' urbanisation from 1978 to 2000, and the regression model revealed a significant and positive coefficient of GDP per capita, suggesting that economic development had a positive effect on China's urbanisation. The positive relationship implied that the rapid economic development could attract more labourers to work and then settle in the cities.

Secondly, labour force employment share of both agriculture in rural areas and industry and service in urban areas are also considered as a widely used measure of economic development with regard to urbanisation (Mills et al., 1986, Zhang, 2002, Li et al., 2014). According to supply impacts on labour force shift mentioned in the previous section, because urban economic growth advances productivity, which provides more opportunities for agricultural labour force to work in industry and services in urban areas, resulting in changes of employment share. This promotion also leads to migration from rural to urban areas, which increases the rate of urbanisation (Li et al., 2014). Also, many researches have tested the influences of employment share on urbanisation. Mills et al. (1986) showed a negative correlation between agricultural employment share and Indian urbanisation in 1960 and 1980, and the result also showed that agricultural employment share were significant to the urbanisation for the Indian case. Similarly, Zhang (2002) reported that agricultural employment share was significantly and negatively correlated with China's urbanisation, indicating a shift of the rural agricultural labour force to urban industry and services due to enhanced urban growth (Zhang, 2002).

According to the above discussion, GDP per capita and employment share are the most common and widely used measures of economic development with regard to urbanisation. For this thesis, using these two economic measures is helpful to test how the economic development influences on Shenyang's urbanisation. Thus, GDP per capita and employment share are selected as two main economic measures to test urbanisation.

3.3.3. Housing investment, economic development, and urbanisation

In order to build a link between urbanisation and housing, this section will review housing on urban development and discuss impacts of housing investment on urban economic development and urbanisation.

Housing development can influence urban development and urbanisation in several ways (Spence et al., 2008). Firstly, housing development with the scale and structure of housing construction can support urban expansion with the most fundamental physical foundation (Mayer and Somerville, 2000). Secondly, housing development with the process of housing supply determines the size and allocation of the urban population (Chen, 2016). In detail, housing supply plays a vital role in determining housing prices, which affect urban employment growth and then the urbanisation level (Glaeser et al., 2005). It can

cause lower employment growth under an inelastic housing supply (Saks, 2008), and can also reshape the spatial distribution of the urban population and even the urban economy under an elastic housing supply (Saiz, 2010). Thirdly, housing investment is highly integrated with the financing of general urban infrastructure and urban public services, which supports the formation of urban amenities and enhances the attractiveness of cities. The process can eventually bring in population migration from outside (Chen, 2016). Moreover, housing development can affect the price movements of housing assets, and through household financing behaviours with regard to housing, the fluctuations in housing prices affect the urban economy, which eventually affects urbanisation indirectly (Cheng et al., 2016, Chen, 2016).

Housing investment is considered to be a key contributor to economic growth and urban development (Topel and Rosen, 1988, Green, 1997, Chen et al., 2011b, Chen et al., 2014), not only because housing business is a significant economic activity, but also because it is believed to be associated with many social and economic benefits (Chen and Zhu, 2008). Harris and Arku (2006) indicated that housing investment might influence economic growth through its impact on employment, savings, total investment and labour productivity, indirectly resulting in urban growth. Dasgupta et al. (2014) evaluated the elasticity of housing investment against changes in an urban population during a fixed time period, in order to investigate the influence of housing investment on urban growth. The research found that the elasticities of housing investment were steadily increasing in developing countries, and OECD countries invested heavily in housing development during periods of rapid urbanisation. The research implies that housing investment has a positive relationship with urban growth in both developed and developing countries. The research also implies that if housing investment does not keep pace with urban growth, cities will be developed under poor living and health conditions, with low productivity. Xiang et al. (2007) investigated urbanisation and housing investment in China from 1986 to 2003, and revealed that both continually rose during the period; the relationship between them was a mutual promoting causality. Peng (2006) indicated there was a positive correlation between fluctuations in housing investment and urbanisation in China, and that the urbanisation process was influenced by fluctuations in housing prices and the floor area of housing sales. Thus, according to these studies, housing investment can be assumed to influence urbanisation.

On the other hand, urbanisation and economic factors can also influence housing investment conversely. Wang and Liu (2006) conducted a case study of housing investment in Beijing using stepwise regression models, and they found that significant drivers of housing investment, including the urbanisation level, were housing prices and stocks, and GDP per capita. Xiang et al. (2007) investigated the urbanisation and housing investment in China from 1986 to 2003, and he revealed that both of them were continually rising during the period and the relationship between them was a mutual promoting causality.

In China, the importance of housing investment to the economy and urban development is evident and widely discussed. According to statistical estimates in the year 2000, every 100 yuan increase in housing investment is expected to produce 315 yuan of gross production in the economy (Chen and Zhu, 2008). Zheng (2003) reported that domestic housing investment was significant to GDP. Li et al. (2005) showed that a 1 percent increase in housing investment would cause a 0.16 percent increase in Chinese GDP. These analyses show that housing investment has a positive influence on the Chinese economy, which has developed a series of industries related to housing, such as construction, material production and building design, etc. (Chen and Zhu, 2008). This also implies that a decline in housing investment will affect these types of industries, resulting in a recession or even companies shutting down. Then, unemployment will occur, firstly in the companies downstream in the industrial chain.

Furthermore, housing policies have been developed and altered in China, thus affecting investment and purchases in the housing market (Dreger and Zhang, 2013). In 1998, the system of welfare housing distribution was abolished through the transition of welfare housing to private property (Dreger and Zhang, 2013, Wang et al., 2005). Before this transition, more than 80 percent of housing investment was from SOEs and government. After this transition, less than half of housing investment was from SOEs and government (Chen et al., 2011b, Chen et al., 2011a). Moreover, Han (1998) examined the regional dimension of housing investment and development in China in order to evaluate the factors that shape regional patterns, and found that there was an evident difference between coastal and non-coastal areas in terms of housing investment. He also indicated that the intensive housing development in the coastal regions was caused by foreign investment, especially investment from Hong Kong, Macau and Taiwan. Thus, according

to the above discussions, urbanisation, economic factors and housing investment may have mutual influences and causalities between each other.

3.4. Housing demand

3.4.1. "Housing demand" and "housing needs"

Housing is one of the basic human needs, and it is the most essential element in urbanisation (Chen et al., 2011a). The terms 'housing demand' and 'housing needs' often appear in housing studies and government policies, so it is necessary to clarify them to avoid confusion.

Heath (2014) defined housing needs in the report *Housing Demand and Need (England)* as shortfalls from certain normative standards of adequate accommodation. Liu et al. (1996) defined housing needs as the quantity of housing required to accommodation of the agreed minimum standard without taking account the household's ability to pay for the housing. While, housing demand is a market driven concept and is defined as the number of houses that households will choose to occupy based on preference and ability to pay. Because housing demand is often based on a defined number of people who want to buy or rent housing, it affects the housing market and ultimately the economy (Heath, 2014). In summary, housing need is a reflection of the basic requirement of accommodation to provide adequate living standards, and it can be created without any constraints or limits. However, housing demand has a constraint of affordability, and it can be considered as general demand for housing in the economic context (Vajiranivesa, 2008). Alonso (1964) indicated some individuals' concerns about housing decisions, including the size of the house, the distance between the city centre and the house, the character of the neighbourhood, the education resources, *etc*. All of these concerns (or tastes) are related to income and prices.

3.4.2. The neoclassical consumption theory on housing demand

Housing demand has been researched for decades, and early models for estimating housing demand were based on neoclassic consumer theory (Megbolugbe and Marks, 1991). The neoclassic economic models have tried to test several assumptions about consumer behaviour, the nature of housing commodity and the attributes of the housing market. The main three factors in those neoclassic economic models were income, price

and preference (Megbolugbe and Marks, 1991). Subsequently, the neoclassical economic theory was applied to housing demand within the framework by Muth (1960) and Olsen (1969), in order to test the assumptions mentioned above. The neoclassical economic theory subordinated the role of consumer preferences in housing decisions to the income and price constraints faced by households. The theory postulated that consumers attempted to spend as much as possible on goods and services, including housing, within the constraints of market prices and their incomes. The attempts to maximise purchasing on housing and other goods by the households defined the general housing demand equation (Megbolugbe and Marks, 1991), as follows:

$$Q = q(Y, P_h, P_0, T) \tag{3.1}$$

Where,

Q: housing consumption

Y: household income

P_h: the relative housing prices

P_0: a vector of other goods prices

T: a vector of taste factors

Because it is difficult to quantify the taste factor (T), some studies introduced a vector of household characteristics (H) such as age, race and marital status, in order to capture differences in consumer preferences unrelated to income and price factors (Megbolugbe and Marks, 1991). Equation (3.2) and equation (3.3) assume the relationship between housing consumption and household characteristics.

$$\text{If} \qquad T = t(H) \tag{3.2}$$

Where,

H: a vector of household characteristics

$$\text{Then} \qquad Q = q(Y, P_h, P_0, H) \tag{3.3}$$

Integrating household characteristics into the housing demand equation provides the key for the conceptual development of housing decision models (Megbolugbe and Marks, 1991). Also, residential mobility was another factor affecting housing choice. Due to the spatial fixity of housing, when a household decides to move, the relocation process affects

a new housing choice (Megbolugbe and Marks, 1991). Thus, variables considering mobility started to be of concern to economists.

3.4.3. Nature of housing product

Housing is a unique good, due to its relatively high cost of supply, durability, heterogeneity and spatial fixity (Megbolugbe and Marks, 1991). Those features determine the demand and supply of housing in the market, which can be described by variables in the economic models. To research housing demand, it is necessary to discuss those distinguishing features.

3.4.3.1. Durability of housing

Durability is the dominant feature of the standing stock of housing, and it raises many issues for modelling housing decisions and housing demand. The durability of housing also has direct implications for how housing demand should be modelled and how income and housing prices should be specified (Megbolugbe and Marks, 1991). This specific feature helps us to understand the housing market in two separate sectors. First, the demand for housing services is driven by consumers, whose demand is modelled in consumption theories in a similar way to any other consumable goods demand (Dusansky and Wilson, 1993). Second, the demand for housing stock is driven by investors, whose demand is modelled in investment theories (Boehm and McKenzie, 1982). The second sector is the distinguishing feature due to the durability of housing, because housing can be rented after the first owner buys it. For this reason, housing demand can be separated into buying and renting (Megbolugbe and Marks, 1991).

Lee and Trost (1978) created a tenure choice model considering both buying and renting, and the relationships between housing ownership and renting can be equated as in equations (3.4)–(3.6). This model can be estimated simultaneously using maximum likelihood, but it can be quite costly and may not converge on a solution (Megbolugbe and Marks, 1991).

$$I = I(X) + u \tag{3.4}$$

$$Q_o = q_o(Z_o) + u_o \tag{3.5}$$

$$Q_r = q_r(Z_r) + u_r \quad (3.6)$$

Where,

I: the unobservable index

X: the household's likelihood of owning versus renting

Q_o: the owner's demand for housing services, a function of the variable Z_o

Q_r: the renter's demand for housing services, a function of the variable Z_r

u: the disturbance term

In sum, the durability of the housing allows itself to be utilised or consumed over a long period of time. The housing can be rented to meet the needs of tenants. Meanwhile, it can make profits for the owners. This process forms the second sector of the housing market for the purposes of housing investment, and it also leads to the essential step of involving economic factors in the model above.

3.4.3.2. Heterogeneity of housing

Heterogeneity is an inherent feature of housing. The neoclassical demand model for housing services is based on standard economic analysis applied to a composite commodity whose units are homogenous (Muth, 1969). Because housing is a multidimensional commodity, standard consumer theory requires modification to incorporate the inherent heterogeneity of housing. Housing units with the same price can differ in size, age, and access to economic and socio-cultural facilities and public services (Megbolugbe and Marks, 1991). The modelling of housing heterogeneity is based on the assumption that households value goods for their characteristics (Muth, 1966). Megbolugbe and Marks (1991) also indicated that these characteristics could give utility or combine with other inputs such as the household's time. Due to housing heterogeneity, this research will focus on the floor area of housing rather than the number of housing units for housing stocks.

3.4.3.3. Spatial fixity of housing

Spatial fixity is another key feature of housing, and it can affect people's decision to buy or rent accommodation (Megbolugbe and Marks, 1991). Previous housing-demand models that incorporated locational factors relied mostly on the characteristic approach (Linneman, 1986). Although the spatial fixity of housing has been viewed as a part of housing heterogeneity, there are many other location specifications affecting housing demand that must be considered. These considerations include distance from important locations, the nature of land use in the neighbourhood of the house, the socio-economic character of the neighbourhood, the physical nature of the neighbourhood environment, and the local government jurisdiction in which the housing stock is located (Megbolugbe and Marks, 1991).

3.4.4. Housing demand models

According to the previous discussion of neoclassical consumption theory, demand for any good or service should be a function of income and price. According to this viewpoint, housing demand per capita should be a function of income per capita and housing prices (Megbolugbe and Marks, 1991, Bajari et al., 2013). The earliest and the most accepted housing demand model is The Muth's Model (1960), in which the desired housing stock per capita is a function of housing prices and incomes. In this model, two price variables were applied to explain the housing stocks per capita: housing prices and mortgage rates. The Muth's Model also allowed for disequilibrium effects in housing markets under a lagged adjustment process, and at any time point, the actual housing stocks were moving to the desired or equilibrium housing stocks. However, the lagged adjustment did not represent the restrictive effect of mortgages on the housing market (Fair, 1972). In Muth's model, the adjustment towards the desired housing stocks was always moving at the same rate, which is not a reasonable assumption for the housing market as mortgages can influence the real housing market (Fair, 1972). Fair (1972) also raised a critical issue for the model: much of the time adjustment might not be restricted, but some of the time adjustment might be restricted too severely.

Following the Muth's Model, many researchers have developed housing demand models with more considerations on housing tenure decisions, household characteristics and preferences, *etc*. Malpezzi and Mayo (1987) estimated a housing demand model for some cities in developing countries. The findings at the household level included: income elasticities of demand among renters were small, between 0.3 and 0.6, and figures among

housing owners were larger, between 0.4 and 0.8. Owners spent more on housing than renters at given income levels, which suggested that variables such as taste and assets were one cause of the consumption differences between housing owners and renters. The findings at the city level included: rent-to-income ratios rose across cities as income increased; owners generally paid a significant premium for ownership, equal to the difference between the opportunity cost of housing capital and the imputed rental value of housing. Ioannides and Zabel (2003) estimated a housing demand model with neighbourhood effects and proved that location and neighbourhood effects could produce a high degree of interdependence between neighbourhoods' demands. The model also provided evidence of both endogenous and contextual neighbourhood effects. The endogenous effect implied that individual housing demand was affected by the mean housing demand of a person's neighbourhoods. The contextual effect implied that individual housing demand was affected by the neighbourhood's characteristics. Bajari et al. (2013) estimated a dynamic structural model of consumer demand for housing and nondurable consumption, and the model stimulated how consumer behaviour responded to housing price and income declines as well as tightening credit. The analysis showed that households' preference were more to climb the property ladder[19] quickly in their early life cycle and to invest more in housing assets due to lower housing prices. The analysis also showed that under a negative income shock, housing demand declined among young-and middle-aged households who stayed in smaller houses rather than to trade houses with similar size and higher value.

Besides those studies mentioned above, many housing demand studies have modelled housing demand with variables, such as Zhou (1997) study on forecasting demand for single-family housing in the United States, Wheaton (1990) study on the relationships between housing vacancy and prices, and Skaburskis (1999) study on housing tenure and building type, affected by household size and age, income and housing prices. All of these models considered housing demand factors that can be classified into two groups. The first group contains demographic factors including household characteristics such as household size and housing preferences. The second group includes economic factors such as income and housing prices, because most of the models were developed from the

[19] Property ladder is a term to describe a series of ascending stages that people are perceived to progress as they are able to buy more expensive houses. It starts from more affordable housing for young and first-time buyers who are at the bottom of the property ladder, to expensive houses for rich people who are at the top of the property ladder.

original neoclassical economic theories of housing demand, focusing on consumer behaviours in housing consumption and the conditions of the housing market.

3.4.5. Factors of housing demand

After reviewing housing demand models, it is necessary to specifically discuss factors of housing demand, in order to introduce related variables into housing demand models for the case of Shenyang. This section will explain the effect of demographic factors and economic factors on housing demand, and also will discuss some other factors such as commuting cost, interest rate and energy consumption that might influence housing demand.

3.4.5.1. The effect of demographic factors on housing demand

Demography is the study of a population that increases by birth and immigration and decreases by death and emigration. In a broader context, demography is also the study of the various determinants of population change and the impact of the population (Wunsch, 2012). This section will review demographic factors on housing demand focusing on population and household size.

Population

Population is commonly cited in the demographic factors of housing demand. Mulder (2006) indicated that the relationship between housing and population was two–sided. From population to housing, people live in household and households need housing. In the long run, housing supply follows housing demand, and the number of housing units approximately reflects the number of households. Because housing is different from other commodities due to its high prices and slow production, the demand for households is more rigid than that for other living necessities that can be purchased much often (Megbolugbe and Marks, 1991). Vermeulen and Van Ommeren (2006) analysed housing supply in The Netherlands and concluded that people would move to regions where housing was built, but housing was not necessarily built in areas where people wanted to live. From housing to population, Mulder (2006) indicated that housing might attract migration, and a lack of housing might prevent migration from outside. He also implied that housing might refrain or postpone household formation if people could not find a suitable place to live. There are two major forms of household formation: separation, such

as divorce; and leaving the parental home, due to marriage, education or work requirements. People who want to leave home for reasons of education or work requirements are likely to accept substandard housing. However, people who want to leave for reasons of independence or marriage can wait until they find suitable or affordable housing (Mulder, 2006, Skaburskis, 1997). Therefore, it is important to investigate further the population factors that have attracted the attention of housing researchers.

Household size

Apart from population at the macro scale, household size at the micro scale has been analysed in housing demand studies. Mayo (1981) also indicated that as household size increased, housing quantity and quality decreased monotonically, and housing expenditure would rise first and then fall. Kain and Quigley (1975) and Maisel et al. (1971) found a positive relationship between housing consumption and household size, while Li (1973) found a negative relationship. David (1962) also found that housing expenditure increased first with household size then decreased. De Leeuw (1971) studied housing demand with different sizes of households. He classified household size into five categories from one-person to six-or-more-persons and reported a lower income elasticity for small households. De Leeuw (1971) then concluded that households with similar demographic features possibly had similar housing demand functions, but these functions were not assumed to be the same for households of different sizes. Furthermore, Vajiranivesa (2008) presented some straightforward examples to demonstrate how population and household size needed to be considered when studying housing demand, as follows:

In any particular geographic area:

- If there is one person, he represents a housing demand of one housing unit
- If there are five persons, they represent a housing demand of between one and five housing units.

In this case, the estimation of housing demand starts from one housing unit, because five persons may like to live together in one housing unit.

- If there are ten persons, they represent a housing demand of between two and ten housing units.

In this case, the estimation of housing demand starts from two units, because it is unlikely that all ten persons would like to live together in one unit.

- If there are N persons, they represent a housing demand between X and Y units.

Then, from the study by Hu (2003), the basic equation to calculate the number of housing units can be expressed as follows:

$$N = P/(n * h) \tag{3.7}$$

Where,

N: the number of housing units

P: population

n: the number of households per unit

h: average members per household

Those examples and equation explain the relationship between housing demand and population factors. In order to understand the population factor deeply, many studies have used housing per person or housing per household to identify housing demand. DiPasquale and Wheaton (1994) used housing stock per household as the independent variable to estimate the housing prices. Zheng and Liu (2005) researched the income elasticity of housing demand using housing consumption per household as the dependent variable. These studies considered a household as a demographic unit. Ioannides and Zabel (2003) used household data for estimating housing demand models. In this study, the number of persons in the household was introduced as an independent variable, implying that the individual was as crucial as the household in demographic factors. Eichholtz and Lindenthal (2014) studied the influence of demographic characteristics at household level on housing demand, and the analysis showed that the housing demand increased with increasing household size.

Furthermore, in recent years, many studies have focused on housing per person, especially in developing countries, because the magnitude and density of the population are considerable. Mesthrige Jayantha and Lau (2008) estimated an empirical housing model for Hong Kong, and the floor space per person was introduced, assuming that the average household size remained unchanged. Chow and Niu (2010) studied China's housing market, and housing space per capita was estimated on both housing demand and supply due to the vast magnitude of the population. Those studies provides research

inspiration to consider population and household size as factors to influence housing demand.

3.4.5.2. The effect of economic factors on housing demand

In terms of the specification of housing demand, it can be seen from consumer behaviour theory that demand for a good or service should be a function of income and the price of the good or service relative to all other prices. Thus, housing demand per capita should be a function of income per capita and the housing price relative to other prices (Fair, 1972, Megbolugbe and Marks, 1991). This section will review income and housing prices as the main economic factors that influence on housing demand.

Income

Income plays a vital role in housing demand models. Income is fundamental to explaining housing demand because it is the source of funds for homeowners' payments of mortgage, interest, property taxes, insurance and utilities, and for renters' payment of their rent (Megbolugbe and Marks, 1991). The major concern regarding housing demand and income is how sensitive demand is to changes in income, which can be described by income elasticity of demand (Mayo, 1981).

In housing demand studies, the debate over whether to use permanent income[20] or current income[21] has been raging for a long time, and there is widespread acceptance of the fact that the elasticity of housing to current income is higher than the elasticity of housing to permanent income (Megbolugbe and Marks, 1991). In the literature, household's decisions on housing expenditure are long run in nature. If household behaviour is consistent with the nature of housing expenditure, then it is appropriate to choose long-run permanent income (Megbolugbe and Marks, 1991).

There are many studies on income elasticity to demonstrate that how income influences housing demand. Carliner (1973) reported renter income elasticity as approximately 0.5 and owner income elasticity as around 0.6 to 0.7 using 4-year average permanent income

[20] Permanent income in economic theory is defined as expected long-term average income, and it is determined by a consumer's assets, including physical aspect (property), financial aspect (salary, shares and bonds in stock market), human aspect (education and experience). Those can influence the consumer's ability to earn income.

[21] Current income refers to people's cash flows or disposal incomes in short-term.

data. Renter income elasticity was calculated by Lee and Kong (1977) as 0.70 and owner income elasticity as 0.87, using 3-year permanent income data. Goodman (2003) studied the housing demand in different age groups for the Detroit metropolitan area, and the results indicated that income had a significant impact on the housing demand with the estimated full income elasticities between 0.30 and 0.35. This study showed that increasing income leading to the choice of owning rather than renting housing increased housing demand separately from the impacts of tenure-specific income increases. Furthermore, there are some recent studies on how incomes explain housing demand in the Chinese context. Chow and Niu (2010) used time series from 1987 to 2006 to study housing demand and supply in China and their results showed a long-run income elasticity of demand for urban housing similar to that in other countries and China in the early 1930s. This study was also considered to be an example of the applicability of standard economic analysis to the Chinese economy (Chow and Niu, 2010). Zheng and Liu (2005) used cross-sectional data to estimate the income elasticity of households who bought commercial housing in Beijing, and the results showed that the income elasticity was 0.86, which was smaller than in developed countries. The result implied that housing in Beijing was still a consumption good and households had few housing investment motives.

Housing prices

Besides income, housing price is another important factor in estimating housing demand. Fair (1972) indicated that if the housing markets were always in equilibrium, the housing prices would clear the housing markets. Equilibrium in the housing market would correspond to a positive number of vacancies, and this number would be the amount needed to meet the normal requirements of market turnover. In the short term, the housing markets may not always stay in equilibrium, so an assumption of disequilibrium needs to specify how the actual quantity of housing will be determined (Fair, 1972).

Fair (1972) also explained a relationship between housing demand and housing supply in the term of quantity, and this relationship influenced housing prices and developers' decisions. Fair's viewpoint is that at any one time there is a certain proportion of housing occupied or available to occupy and another proportion of housing under construction. Thus, the housing supply at any one time is fixed. At the existing set of prices, if the housing demand is equal to the available housing supply minus the housing vacancies, then the housing market is in equilibrium, otherwise not. If the housing demand is larger than the available housing supply minus the housing vacancies, then the actual vacancies

will be less than normal, and people may start to buy or rent at the available prices. This situation will cause the prices to rise, and then developers respond by building more than the normal demand based on removals and population growth. If the housing demand is less than the available housing supply minus the housing vacancies, then the actual vacancies will be higher than normal, and people start to sell at the available prices. This situation will cause the prices to drop, and then developers respond by building less than the normal demand. Thus, how fast the housing market moves to equilibrium depends on how fast developers respond to disequilibrium (Fair, 1972).

Many studies discuss how housing prices affect housing demand. Fontenla and Gonzalez (2009) researched housing demand in Mexico using micro-level data during the period of 2002 to 2004 for 21 metropolitan areas, and found that the price elasticity of housing demand was -0.3, lower than previous studies for developed countries and within the range for developing countries. Chow and Niu (2010) used OLS models with time series data from 1987 to 2006 to investigate the influence of housing prices on housing demand and housing supply. The price elasticity of housing demand was between -0.5 and -0.6. The interaction of demand and supply explained the housing prices at the aggregate level in China very well, and the analysis also implied that housing prices in China were not the result of speculation. Then Chow and Niu (2015) applied AR models with time series data from 1987 to 2012 based on the standard theory of consumer demand, supplemented by a partial adjustment mechanism to explain the demand for urban housing in China. The result showed that the housing demand was explained well by real income and relative housing prices, and the price elasticity was around -1.1. Gu et al. (1999) used panel data from 1988 to 1993 to estimate the income and the price elasticity of housing expenditure on demand in Taiwan. The interesting point in this research was that it separated owner-occupied households into two groups: households with only one house and households with more than one house. Firstly, the results showed that the housing price elasticities were -1 and -0.98 for renters and owners respectively. Then, the study estimated housing price elasticity for all owners, owners with one house only and owners with more than one houses, and the elasticities were -1.11, -1.14 and -1.05 respectively. The study concluded that housing was not only a common good with a pure consumption demand but also a luxury good for homeowners.

3.4.5.3. Other factors related to housing demand

Apart from demographic and economic factors, there are some other factors that influence housing demand. This section will review location commuting costs, interest rate, rental cost and energy consumption, in order to introduce related variables into the housing demand models.

Commuting costs

The location of housing is another big concern for any individual household, and in any period each household making a residential choice gathers information on the spatial locations of housing and the market prices of houses at these locations (Quigley, 1976). For each possible location, households consider accessibility costs in their housing budget and calculate the total living costs of the housing at the location. In accessibility costs, travel to work is the essential component, having a strong influence on how different households choose their residential locations (Quigley, 1976).

Albouy and Lue (2015) indicated that workers who lived far from work would spend less on housing but considerably more on commuting costs, and this builds a link between commuting costs and housing demand. Many studies researched how commuting costs with location concerns influenced housing demand. Muth (1969) discussed the relationships between land expenditure and location and indicated the distance where the marginal savings in land expenditure exactly balanced the increase in commuting costs. He also argued that if a consumer with a higher income had the same marginal travel cost but higher land consumption, then the residential choice would be further from the central location. On the other hand, if a consumer's commuting costs were substantially higher while his land consumption was almost the same, then the residential choice would be closer to the central location. Alonso (1964) also discussed the influences of residential location on travel distance and costs with his so-called "bid price" approach to the urban land market. In his study, the market was viewed as an auction place, and consumers offered bids for the use or purchase of land. The bid price of land was affected by the cost of housing and travelling distance, and the cost of other goods. From the demand aspect, the study concluded: if the land is more income elastic than travel costs, then people with higher income will live further from the city centre; if the land is more travel cost elastic than income, then rich people will live closer to the city centre. Polinsky (1977) indicated that commuting was instantaneous but required money expenditure, which increased strictly with distance. Earlier studies also reported that travelling distance and commuting

costs influenced housing choices (Polinsky, 1977, Quigley, 1976). Recent studies have also confirmed the importance of commuting costs for housing demand. Zheng and Zhang (2007) used cross-sectional data to regress housing prices and housing demand respectively in Beijing, and commuting time was found to be significant for both housing prices and housing demand. Assuming that commuting costs increase with commuting time, the authors implied that the trade-off between housing costs and commuting costs was considered by the consumers. According to the discussions above, it provides a research inspiration that commuting cost may have an impact on household's decision on housing location that influences on housing consumption and housing demand.

Interest rate

Moreover, apart from income and housing prices, interest rate is another factor that influences housing price that can further affect housing demand, as interest rate determines the cost of mortgage interest repayments (Taylor, 2007). In detail, in certain period, higher interest rates will increase cost of mortgage payments and will cause lower demand for homebuyers. Also, higher interest rates make renting houses relatively more attractive rather than buying houses (La Cava, 2016). Conversely, lower interest rates will decline the cost of owning and then effectively increase in housing demand that leads to higher relative housing prices. The rise in the relative housing prices in turn leads to an increase in the share of spending on housing, so housing demand will increase subsequently (Ellis, 2005). Thus, interest rate plays important role on housing demand and household' decisions on housing.

Many research discuss how interest rate affects housing prices and housing demand. La Cava (2016) analysed the determinants of housing rental income and housing prices in the US economy and indicated that the housing rental income could rise as a result of a higher relative housing price or a higher relative housing demand. The study discussed that the observed long-run decline in interest rates should have lowered the price of renting relative to owning but have increased the price of owner-occupied housing through higher housing demand. Fontenla and Gonzalez (2009) estimated housing demand of 21 metropolitan areas in Mexico and found the mortgage interest rate elasticity for 25-year mortgages to be -0.39, suggesting that lower mortgage rates could play an important role in housing demand. The results of the study also indicated that the housing demand elasticity of price and interest rate were similar, which directed government to reduce mortgage interest rates by housing affordability policies.

Rental costs

Renting is an alternative way to own housing temporarily, and rental costs have been used as a variable for housing demand models in the past (DiPasquale and Wheaton, 1994). It appears that owning a house becomes relatively much more expensive when housing prices increase rapidly, as rental prices move slowly (Dıaz and Luengo-Prado, 2011). Generally, if the quantity of housing demand is equal to the housing supply less the normal level of vacancies, the housing market is in equilibrium. However, if the housing demand is greater than the housing supply less the normal level of vacancies, there might be people who would like to rent housing at available prices (Fair, 1972).

In the earlier housing demand research, elasticities of income and price to housing demand were investigated in the classifications of renters and housing owners, such as Carliner (1973), Kain and Quigley (1975) and De Leeuw (1971). Poterba (1984) researched housing user cost, and the theoretical base for the study was that the desired quantity of housing (housing demand) depended on the real rental price. DiPasquale and Wheaton (1994) applied the rent index to identify the alternative cost of renting in the housing demand model and housing price determination equation, and found a negative relationship to housing prices. Sommer et al. (2010) developed a dynamic equilibrium housing model with specified markets for homeownership and rental properties and found that housing prices and rents were determined endogenously.

Energy consumption

Recent studies shows that increasing residential energy use is connected to housing consumption (Ewing and Rong, 2008). Generally, larger houses consume more energy than small houses because there is much more space to heat and cool (Fuller and Crawford, 2011, Ewing and Rong, 2008). Linking to demographic factors, many studies have also found that housing demand depends on household characteristics such as household size and ethnic background (Skaburskis, 1997), and generally more people living in the same size accommodation consume more energy for residential use.

Many research discuss how residential energy use affects housing demand. Ewing and Rong (2008) studied the relationship between residential energy use and housing size and other control variables using OLS regression analysis. The variables included housing size and type, housing age, household income and race, household composition and energy prices. The results showed that residential energy demand decreased with

increasing energy prices, increased with increasing household income and varied by household race. The results also confirmed that energy use was positively linked to housing size. Zheng et al. (2014) carried out a comprehensive survey of 1,450 households in 26 Chinese provinces to identify the characteristics and potential driving forces of residential energy use in China, and dwelling size and energy prices were considered in the survey. The research examined energy consumption and its driving forces in Hangzhou, China, and housing size (including floor area and number of rooms) and household characteristics (including size, annual income and members' ages) were investigated by correlation analysis. The positive correlation coefficient implied that energy consumption grew when income and housing size increased, but a negative correlation coefficient of age suggested that older people consumed less energy than young people. This review shows that there is a connection between housing size and energy consumption, and this has been researched by many scholars. Thus, we assume that energy consumption might affect housing demand per person.

3.5. Housing densification

3.5.1. Urban compactness and housing densification

The spatial patterns of human activities create urban forms gradually, and urban compactness as one primary urban form is discussed widely today. Urban compactness can be interpreted in two ways. One abstract interpretation of urban compactness is the idea of the autonomous city, as advocated by (Scoffham and Vale, 1996). This kind of city is compact in the sense of self-sufficiency and independence from outside forces. The other abstract interpretation of urban compactness is spatially compact, resulting from high-density living and efficient transport planning, for example the 'virtual city' of Thomas and Cousins (1996). In the spatial sense, urban compactness can be generally defined as mono-centric and high-density urban development, including a specific concentration of housing and employment and a mixture of urban land-use (Gordon and Richardson, 1997, Daneshpour and Shakibamanesh, 2011, Ewing, 1997).

Burton (2002) summarised the advantages of urban compactness as including conservation of the countryside, a reduced need to travel by car thus lower fuel emissions, support for public transport and walking and cycling, better and easier access to services and facilities, more efficient utility and infrastructure provision, and revitalisation and regeneration of inner-urban spaces. These advantages are viewed as the objectives of

more sustainable development, which embraces social and economic sustainability as well as environmental concerns.

Burton (2002) also divided the compact city into three types: the high-density city; the mixed-use city; and the intensified city. The first two types view the city as a 'product', and in the other it is seen as a 'process'. The high-density city is probably the most common interpretation of the compact city. For example, The UK government aims to apply higher densities to achieve sustainability and good urban design, and the US government promotes higher densities for reducing car-dependency and avoiding urban sprawl (Burton, 2002).

In terms of the high-density city, Burton also summarised four different aspects to identify the concept of density: high average density of population; high density of built forms; high-density sub-centres; high-density housing forms.

A high average density of population is associated most strongly with sustainable travel behaviour, as high residential densities may reduce car use by increasing walking opportunities (Burton, 2002). High population densities positively support public transport and provide the density of demand to create local facilities and services. They also increase opportunities for communication and interaction between people by living closer together (Burton, 2002, Force Urban Task, 1999).

High density of the built form reflects the development situation and how built up an area is. On the other hand, high density of the built form can result in the loss of open or rural land. The Force Urban Task (1999, p.60) indicated that "as density is increased - even to the moderate levels of 40 or 60 dwellings per hectare – the land-take diminishes rapidly". The Department of the Environment Transport and the Regions (1998) also found that significant land savings could be achieved by avoiding development below densities of around 20 dwellings per hectare. Thus, high density of the built form focuses on how densely an area is developed, rather than how much population an area contains.

High-density sub-centres or decentralised concentration focuses on the pattern of high density across the city. Burton (2002) stated that some sustainability arguments such as support for local facilities and services rely on high residential densities rather than high densities overall across the city. Haughton and Hunter (2004) described the compact city as a city with a dense core, with the inner area of the city having much higher densities than the surrounding areas. Related to the transport aspect, the compact city can be viewed

as a ‘decentralised concentration’ that is developed along public transport corridors. This density concept generally works in large-scale areas, such as cities and regions.

High-density housing forms can help cities to achieve the goal of compactness with considerations of housing design. The term ‘high-density’ is a relative concept, and high density should be compatible with the character of the local areas. Thus, different countries or different cities should have their own perceptions of high-density housing forms (Burton, 2002). For example, in developed countries such as the UK, high-density housing forms refer to building types such as terraces and apartments, compared to low-density forms like houses, and these compact housing forms are supported for their energy-efficiency advantages by the UK government (Burton, 2002). In developing countries such as China, medium-rise and high-rise housing with high-density arrangements has been popular in recent years, as it can meet residential demand for a considerable proportion of the urban population with a relatively limited residential land provision (Wang and Murie, 1999, Zhu and Lin, 2004). Overall, high-density housing forms can provide more opportunities and better conditions for social interaction and community than low-density housing forms (Burton, 2002).

Galster et al. (2001) indicated that urban compactness is a way to achieve sustainable urban development and avoid excessive urban land-use. However, extreme urban compactness may result in town cramming (Hall, 2001), lack of open and green space (Breheny, 1992), and an inflation in housing prices due to urban containment policies[22] (Dawkins and Nelson, 2002).

Housing densification is considered to be a crucial factor in the development of a compact city; it helps to avoid urban sprawl and achieve urban sustainability (Gordon and Richardson, 1997, Daneshpour and Shakibamanesh, 2011). In the US, housing

[22] Urban containment policies encourage infill development and redevelopment inside a defined urban area, rather than applying traditional approaches to land use regulations that are explicitly designed to limit the development of land outside the urban area. Urban containment policies can change housing prices for two reasons: first, land prices change when land supply changes; second, if urban containment policies increase the value of the amenity package associated with housing, the housing prices will change. In microeconomics, housing prices are affected by urban containment policies, because land supply is constrained and fails to accommodate new housing demand.

densification policies within "smart growth"[23] aim to restrain urban sprawl by integrating land-uses with housing and increasing housing densities in existing urban areas (Ye et al., 2005). In Europe, the compact city idea originated with Ebenezer Howard's Garden City[24], which was introduced as a way of promoting a sustainable urban form for European cities through the European Commission's Green Paper on the Urban Environment in 1990 (CEC, 1990). Generally speaking, if a city has enough space available for new housing construction or higher residential densities, this can be carried out in several ways. For example, a continuing demand for housing units can be fulfilled by building in existing urban areas, which is referred to as urban residential densification. Otherwise, the city has to expand and seize its surrounding areas, which is referred to as urban expansion. These two processes imply urban housing density changes (Broitman and Koomen, 2015). Therefore, as the primary characteristic of urban compactness, housing densification not only covers high housing density (McLaren, 1992), but also intensive land-use (Newman and Kenworthy, 1989). The most commonly used measures of urban compactness are related to density, so the next section will discuss different density measurements, mainly focusing on housing.

[23]The term "smart growth" has been adopted as a planning agenda since 1990. Nelson and Wachter (2000) indicate that the goals of smart growth are to preserve public goods, minimise adverse land-use interactions and maximise positive ones, minimise public fiscal costs, maximise the accessibility of jobs and housing for all households, and maximise quality of life. Porter (1999) notes five general operational objectives as: control the outward expansion of urban areas (containing urban sprawl); stimulate inner-area revitalisation; use design to create attractive places; preserve natural resources; and reorient transportation.

[24] In 1989, Ebenezer Howard published *To-morrow: A Peaceful Path to Real Reform*, and in this book he idealised a garden city that would house 32,000 people within a concentric patterned site of 2,400 hectares. The garden city was also planned with open spaces, public parks and six radial boulevards extending from the city centre. Howard also idealised that the garden city would be self-sufficient, which means that besides residential uses the city would have its industry and agriculture. This idea was based on proportionate areas of residences, industry and agriculture, which would make the city compact. When a garden city reached its population margin, another garden city would be established nearby. Then, a cluster of garden cities would appear, and each satellite city would be linked by road and rail. In practice, the first two garden cities were built based on Howard's idea: Letchworth Garden City (1903) and Welwyn Garden City (1920) in the UK. Then the garden city movement spread across the world.

3.5.2. Density and its measurements

Density is frequently cited when discussing urban sustainability alongside land-use mixture, urban layout, transport, housing form and design quality; mixed-use urban forms with high density are believed to be a sustainable urban form (Dempsey et al., 2012, Jenks and Jones, 2009). From the residential aspect, Cheng (2010) summarised density in two perspectives: physical density and perceived density. Physical density refers to "a numerical measure of the concentration of individuals or physical structures within a given geographical unit", and it is "an objective, quantitative and neutral spatial indicator" (Cheng, 2010, p.4). Perceived density is defined as "an individual's perception and estimate of the number of people present in a given area, the space available and its organization" (Cheng, 2010, p.12). In perceived density, spatial characteristics of an area are important, and the more important concerns focus on the interaction between the individual and the environment as a whole (Cheng, 2010).

3.5.2.1. Population density measurements

In physical density, there are two main categories of density measurement: population density and building density (Cheng, 2010, Ng, 2009). Within the category of population density are regional density, residential density and occupancy density (Cheng, 2010). Regional density and residential density are the ratio of a population to the land area of a given area or region. Occupancy density is the ratio of the number of occupants to the floor area of an individual habitable unit. The area is usually defined by a municipal boundary that covers both developed and undeveloped land. Regional density is often used as an indicator of population distribution in national planning policies (Cheng, 2010).

Residential density is the ratio of a population to residential land area, and this density measure can be further classified in terms of net and gross residential densities based on the definition of the area (Cheng, 2010). Occupancy density is the ratio of the number of occupants to the floor area of an individual habitable unit. The habitable unit can be any kind of private or public space, such as a dwelling, office or theatre, but the floor area usually refers only to an enclosed area. This density measure is used as an indicator for estimating the services required in a building, such as electricity demand, space cooling, heating load and the provision of fire safety facilities (Cheng, 2010). Occupancy rate, as the inverse measure of occupancy density, is the ratio of the floor area of an individual unit to the number of occupants, and it is commonly used as an indicator of the space

available for individual occupants. In building design, a higher occupancy rate means a larger habitable area for individual occupants, and a minimum occupancy rate is often used to ensure the health and sanitary conditions of habitable spaces (Cheng, 2010).

3.5.2.2. Building density measurements

Building density comprises net residential density, gross residential density (Ng, 2009), plot ratio or floor area ratio (FAR), and site coverage or building coverage ratio (BCR) (Cheng, 2010, Ng, 2009). Each of these measurements has a specific focus in terms of urban density and can be used in particular cases of analysis.

Net residential density and gross residential density

Net density is the most straightforward measurement of urban density; it is easy to understand and commonly used in planning and urban design. In the UK context, net residential density refers to land covered by residential developments in addition to gardens and other parts of the plot, and it also includes a half width of the adjacent road (Ng, 2009, Cheng, 2010). The net density is often measured in two ways: dwellings per hectare (dph) or habitable rooms per hectare (hrh).

There are slight differences between these two units. The Department of the Environment Transport and the Regions (1998) states that dph is the most appropriate measure to understand land requirements for development, as it shows precisely how much land should be allocated for a defined number of dwellings. Habitable rooms per hectare (hrh) is a more accurate measurement, and it shows how many more people can be accommodated in an area when the physical density increases.

Nikeghbali (2017) indicated that net density was commonly used for measurements at the neighbourhood scale. One of the main reasons for this is that the net density does not count supporting facilities such as schools, hospitals and other amenities that may serve more than one neighbourhood. This measurement provides an overall vision of a neighbourhood form, although it cannot independently show the specific character of the urban form. The main issue with net density is that the size of the housing is not counted, and the organisation of dwellings within blocks does not influence the net density. Such factors in net density can significantly change the features of an area.

Gross density is similar to net density. Compared to net density, gross density covers other facilities such as schools, parks, public buildings and main roads. Due to the nature

of gross density, it is commonly used on a large scale and in neighbourhoods, because it covers land and spaces that serve a large area.

Barton (2013) indicated that for a specific case, significant changes might not affect net density when counted in gross density, because large areas with large parks and other facilities do not influence the net figure by increasing the number of dwellings. Thus, increasing the number of dwellings has less influence on gross density. Conversely, reducing the amount of land for a larger scale can significantly increase gross density, while it may not affect the local net density on a smaller scale (Nikeghbali, 2017).

Building coverage ratio (BCR) and floor area ratio (FAR)

Building coverage ratio (BCR) is the ratio of the total standing area of all buildings to the total area of the defined area; it estimates the building density in two-dimensional building stretching (Wu and Li, 2010, Pan et al., 2008). This measure is often used for figure-ground analysis and to represent the building coverage as the distribution of built mass and open space (Pont and Haupt, 2010).

Floor area ratio (FAR), sometimes called plot ratio, floor space ratio (FSR) or floor space index, is the ratio of the gross floor area of all buildings to the total area of the defined area; it estimates the building density in three-dimensional building growing (Ng, 2009, Wu and Li, 2010, Pont and Haupt, 2010). This measurement can support the net density measure to increase understanding of the characteristics of development on a defined piece of land (Department of the Environment Transport and the Regions, 1998).

Net density measured by dwelling per hectare (dph) and habitable rooms per hectare (hrh) may not demonstrate the exact volume of development because the sizes of the dwellings and rooms may differ. For example, a dwelling with 50 m^2 has the same net density or gross density as a dwelling with 100 m^2 on a defined piece of land, because the net density is measured by the number of dwellings or rooms. Moreover, in many developing countries, due to a shortage of residential land with high population densities, multi-family residential buildings are widely used, compared to single-family housing in western countries with relatively low densities. This results in the prevalence of medium-rise and medium-high-rise or even high-rise buildings for residential use. In this situation, net density and gross density cannot reflect the housing needs, because one building is occupied by many households. Therefore, for this kind of case, plot ratio can be a better measurement. The Department of the Environment Transport and the Regions (1998)

indicates that net density or gross density is a simpler and more understandable measure for comparing development densities, but FAR and BCR can be used for more in-depth analysis because they take housing size into account.

DETR (1998) also suggests that FAR and BCR, in addition to other building factors such as footprint or building height, can establish a more accurate relationship between the density and characteristics of the urban form. Pont and Haupt (2010) demonstrate that a combination of BCR and FAR with other measurements, such as building height and footprint, can be used to present a formal typology of an area. Therefore, BCR and FAR are the most critical measures for describing density, often in conjunction with other supporting measurements.

According to the definition of FAR, an increase in density refers to an increase in floor area in a defined area. This increase may be due to either increasing the number of houses or extending the size of houses without changing the quantity. Therefore, sometimes density changes measured by FAR do not mean that more people are living in the area. However, a higher density measured by FAR generally implies a development with a higher number of housing dwellings, because housing size in a region or city is typically controlled within a certain range (Nikeghbali, 2017).

Through the above reviews, we can see that density can be measured and expressed in a variety of ways. The density measurements mentioned above are either population oriented or building oriented. In each focus, different density measurements are appropriate in different situations and are suitable for their own research aims. According to these new definitions of density, they all use land area as the denominator but have a different choice of numerator. The choice of numerator depends on the phenomenon under investigation. For example, when considering infrastructure, population density is appropriate as people are the object of study or regulation, and it is most appropriate for defining catchment areas for infrastructures that serve people, such as hospitals and schools. However, dwelling unit density is more appropriate for the provision of infrastructure services, such as water and sewer pipes, roads, and electricity to buildings (Taylor and Van Nostrand, 2008). Thus, many scholars indicate that there is no consensus or standard measure of density, but there are only measures that are more widely used than others (Burton et al., 2003, Ng, 2009, Cheng, 2010). This chapter aims to research the issue of spatial housing densification in Shenyang, focusing on building rather than population. Therefore, physical density measurements are most appropriate.

3.5.2.3. Housing density research for Chinese cities

In China, the first use of BCR and FAR in urban planning can be traced to the 1980s. In the 1980s, with the development of the detailed regulatory plan, BCR and FAR began to be paid attention in urban studies. Liang (1992) indicated that the determination of BCR and FAR must consider the city size, the investment and arrangement of urban infrastructures, and the supply of land market. He also stated that the urban planning for Chinese cities should consider the population density as the primary indicator, rather than the housing density. He (1996) studied the constraints of housing density and indicated that BCR and FAR should be determined by the social and economic environment, reflecting the efficiency of land-use. Zhu (1992) indicated that the determination of BCR and FAR should follow the requirements of the economic reform, which could stimulate the real estate business. Lin (1994) analysed the relationship between land prices and FAR and concluded that excessive controls on FAR could not maximise the economic benefits of the land.

Moreover, there are many studies on residential FAR, focusing on how to reasonably determine FAR for residential communities and how to understand and analyse FAR from the perspective of urban design. Chen (2006) researched the determinations of residential FAR and concluded that in the current Chinese situation it should be determined by economy development, population magnitude and land-use efficiency in a macro sense, and by housing spatial forms and residential cultures in a micro sense. Zhai (2006) indicated that besides economic and population considerations, the arrangements of urban infrastructure and living environments are also crucial for FAR determinations. Due to rapid urbanisation and high housing demand, new housing constructions on limited urban land have resulted in a massive wave of medium-rise and high-rise residential buildings being constructed in many Chinese large cities. As a result, high FAR has attracted attention in urban design (Zhai, 2006). Chen and Xiao (2007) analysed the situation of high FAR with increasing living space due to the rapid urbanisation process and they indicated that new housing constructions should strengthen the control over high FAR in housing, based on the principle of agricultural land conservation, in order to prevent over-housing development and to minimise the impact of human activities on the natural environment. Other studies include that by Yang (2004) on the analysis of the factors that

influence houses' FAR, and that by Yu and Wang (2003) on the study of houses' FAR and residential quality, *etc*.

3.6. Chapter summary

This chapter reviews the existing literature on urbanisation, housing demand and housing densification, including their definitions and influencing factors. The section on urbanisation demonstrated that urbanisation is a critical factor of the urban development process and it is also a result of economic development. The relationship between urbanisation and economic development is significant, and many studies have found that the level of urbanisation is closely correlated with some economic indicators, such as GDP and the employment rate. It has also been demonstrated that urbanisation is connected to urban housing through housing investment. The section on housing demand showed that because rapid urbanisation results in a massive urban population living in cities, housing demand will increase. It was demonstrated that housing demand can be explained by the consumption theory and it can be tested by demographic, economic and other factors. The section on housing densification explained that a high-density city is subject to urban compactness, and high-density housing is an important element of a high-density city. This section focused on the reviews of housing density and its measurement distinctions.

Through the literature reviews, this chapter has achieved some of the research objectives mentioned in **Chapter 3**, and it has provided a knowledge base for the thesis. The next chapter will discuss the methods, techniques and data for each embedded unit.

4. Methodology and research designs

4.1. Chapter introduction

This chapter presents a comprehensive overview of methodologies adopted across the whole thesis, including why choose case study as the main methodology for the study and methods and techniques for investigating the three embedded units. Firstly, the thesis distinguishes between case study method and other research methods and explains why choose case study method for the study. Secondly, the thesis discusses the philosophy of social science with regression analysis and presents the method of multiple regression with the OLS method with time series data for urbanisation and housing demand, and the method of housing density with its changes for housing densification, respectively. This section prepares the theoretical base of the methods for each embedded unit. Thirdly, the chapter presents the model estimations and discusses the model specifications for the units of urbanisation and housing, respectively. Finally, it explains how the GIS technique with spatial aggregation works for the unit of housing densification. Finally, in the section on data issues, it discusses data collection, proving data reliability and data adjustment for data accuracy.

4.2. Why choose case study as a methodology?

4.2.1. Differences between the case study method and other methods

After identifying the research questions and the corresponding research objectives, it was time to decide an appropriate research method for this thesis. According to Yin (2017), there are main five different research methods: experiment, survey, archival analysis, history and case study. The way to distinguish the five research methods is based on the three main conditions of research: the form of the research question posed; the control a researcher has over actual behavioural events; and the degree of focus on contemporary as opposed to entirely historical events. Table 4.1 presents these three conditions for those five research methods.

Table 4.1 Relevant situations for different research methods

Method	Form of Research Question	Requires Control Over Behavioural Events?	Focuses on Contemporary Events?
Experiment	How, why?	Yes	Yes
Survey	Who, what, where, how many, how much?	No	Yes
Archival Analysis	Who, what, where, how many, how much?	No	Yes/ no
History	How, why?	No	No
Case Study	How, why?	No	Yes

Source: Yin, 2017

With regard to the form of the research questions (Table 4.1), this thesis mainly focuses on 'how? questions, e.g. how the driving factors influence urbanisation and the housing demand of Shenyang. The questions are more explanatory and likely to lead to the use of a case study, history, or experiment as the preferred research method, because such questions "deal with the tracing of operational processes over time, rather than mere frequencies or incidence" (Yin, 2017, p.10).

According to Yin (2017), the history research method has virtually no such control and works on "dead" past cases[25]. Moreover, the researchers must rely on primary documents, secondary documents, and cultural and physical artefacts as the main sources of evidence. Compared to the history research method, a case study is preferred "when the relevant behaviours still cannot be manipulated and when the desire is to study some contemporary[26] event or set of events" (Yin, 2017, p.12). Also, the case study method relies heavily on two sources of evidence that are not usually available for a history research method: direct observation of the events being studied; and interviews with the

[25] "Dead" past case refers to a case where it is impossible to conduct direct observations or no relevant persons are alive to report.

[26] "Contemporary" here refers to a fluid process of the recent past and the present, not just the present.

individuals who may still be involved in those events.

According to Yin (2017), the experiment research method requires researchers to manipulate behaviour directly, precisely and systematically. This often happens in a laboratory setting, focusing on one or two isolated variables (and presuming that the laboratory environment can control for all the remaining variables beyond the scope of interest) or in a field setting. Here, the term *field* (or *social*) *experiment* has emerged to cover research where researchers "treat" whole groups of people in different ways, such as providing or not providing them with different kinds of vouchers to purchase services.

Moreover, Yin (2017) provides a two-fold definition of the case study research method. The first part defines the scope of a case study: it "investigates a contemporary phenomenon (the "case") in depth and within its real-world context, especially when the boundaries between phenomenon and context may not clearly evident" (Yin, 2017, p.15). This means that a case study aims to understand a real-world case and it assumes that such an understanding is likely to involve important contextual conditions pertinent to the case. This part of the definition also helps to distinguish a case study from the other research methods. For example, the experiment method deliberately separates a phenomenon from its context in a laboratory setting. The history method is able to research the situation between a phenomenon and its context but it usually focuses on a non-contemporary case. The survey method can also deal with phenomenon and context, but its ability to investigate the context is extremely limited[27]. The second part of the definition is given because phenomenon and context are not always sharply distinguishable in real-world situations. In detail, Yin (2017, p.15) indicates that the case study method "copes with the technically distinctive situation in which there will be many more variables of interest that data points, and as one result; benefits from the prior development of theoretical propositions to guide design, data collection, and analysis, and as another result; relies on multiple sources of evidence, with data needing to converge in a triangulating fashion".

Linking to this thesis, the research questions are set around Shenyang's urban

[27] Yin (2017, p.15) in his book describes the extremely limited survey method means. For instance, the survey designer constantly tries to control and limit the number of items in a questionnaire (so that the number of questions can be analysed) to fall safely within the allotted degrees of freedom (usually constrained by the number of respondents who are to be surveyed as well as the presumed variability in the likely response sets).

development, which covers three specific topics: urbanisation, housing demand and housing densification. Each research topic is designed to investigate a contemporary phenomenon during a certain research period. Furthermore, all the phenomena are not "dead" past events; they still have ongoing trends in the future[28]. Also, different areas and regions may have different urban developments, in terms of their locations, cultures and levels of development, and no general analysis can capture the accurate causes and consequences of urban development for a random area or region. Therefore, there are boundaries between the real situation and the existing context. Moreover, in order to answer the research questions, this thesis will rely on multiple sources of evidence and data, and also benefit from the prior research to guide the research design and analysis and investigate in depth the urban housing issues of Shenyang. All of the above factors confirm the definitions of the case study method. Thus, this thesis has chosen the case study as a research method.

4.2.2. Why single-case (embedded) design

After identifying this thesis as case study research, it is now useful to consider the differences in research design between a single-case study and a multiple-case study. Yin (2017) categorises case study research designs into four types: single-case holistic designs; single-case embedded designs; multiple-case holistic designs; and multiple-case embedded designs. Figure 4.1 covers all four types of design, based on the 2*2 matrix, and the matrix shows that every type of design includes the desire to analyse contextual conditions in relation to the "case".

[28] According to *Shenyang Urban Overall Development Proposed Plan 2011-2020*, the urban population is estimated to reach 7.25 million in 2020, with 2 million growth compared to 5.28 million at the end of 2014. The housing space aim is 35 m^2 per capita. This means that urbanisation has an ongoing trend to increase. Also, in order to settle this urban population, the housing demand will increase. Eventually, due to the increasing housing demand, new housing constructions will occur, resulting in increasing housing densification.

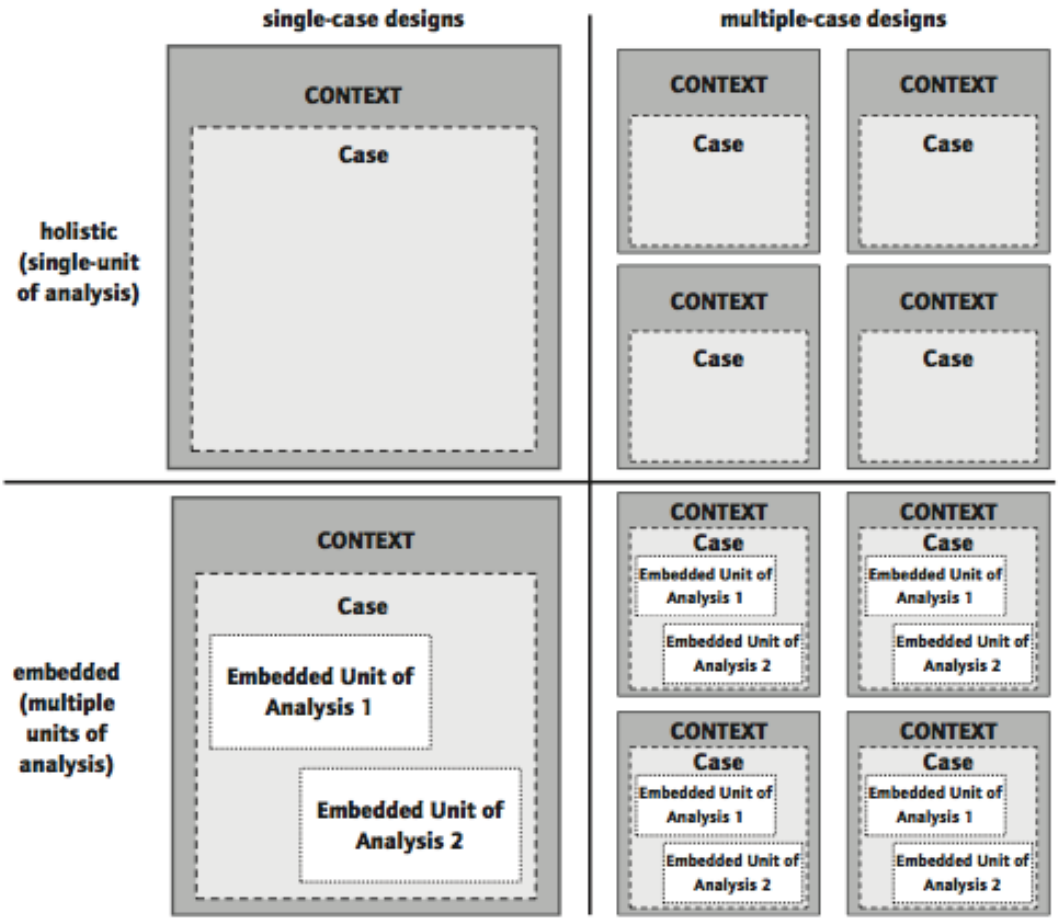


Figure 4.1 Types of designs for case studies

Source: Yin, 2017

It is clear to see that the most evident distinction between a single-case study and a multiple-case study is that the former implements a single case and the latter implements more than one case. Another difference between a single-case study and a multiple-case study is that in the latter, the researcher studies multiple cases in order to understand the differences and similarities between the cases (Stake, 1995). Also, the researcher is able to analyse the data both within each situation and across situations (Yin, 2017).

Both case study designs have their features and advantages. In detail, a single-case study has five rationales: *critical*, *unusual*, *common*, *revelatory*, or *longitudinal* case (Yin, 2017). The first rationale, *critical*, means that selecting a *critical case* would be critical to the theory or theoretical propositions. The theory or theoretical propositions should have specified a clear set of circumstances within which its propositions are believed to be true. In this way, the single-case study can present a significant contribution to knowledge and theory building by confirming, challenging or extending the theory (Yin,

2017). The second rationale for a single-case study is *unusual*, meaning that the case represents an extreme case or an unusual case that deviates from theoretical norms or even everyday occurrences (Yin, 2017). The third rationale, *common*, is viewed as a converse to the second rationale, as its objective is to capture the circumstances and conditions of a common situation. This rationale means that the case might provide information about the social processes related to some theoretical interest (Yin, 2017). The fourth rationale, *revelatory*, means that the case provides an opportunity for the researcher to observe and analyse a phenomenon that was previously inaccessible to social science inquiry (Yin, 2017). This can be understood as a conclusion and recommendation resulting from a research analysis or evaluation. The fifth rationale, *longitudinal*, refers to studying a case at two or more different points in time, because the theory of interest would likely specify how certain conditions and the underlying processes change over time.

Compared to a single-case study, a multiple-case study has distinct advantages and disadvantages. The evidence from multiple cases is often considered potentially more compelling, so the multiple-case study is therefore considered to be more robust overall (Yin, 2017). On the other hand, a multiple-case study can be enormously expensive and time consuming to conduct (Yin, 2017). The existence of a phenomenon can be described by a single-case study. For creating high-quality theory or theoretical propositions, a single-case study is better than a multiple-case study because a single-case study can produce extra and better theory (Siggelkow, 2007).

Embedded units of analysis can be introduced into a case study, which means that the researcher is able to analyse the data within the case, or to make a cross-case analyses between the cases (Gustafsson, 2017). This is reflected in single-case (embedded) and multiple-case (embedded) studies, as seen in Figure 4.1. The application of embedded units provides the researcher with the ability to investigate subunits that are located within a larger case (Yin, 2017). Eisenhardt (1991) indicated that the number of units in a case study depends on how much new information the cases provide and how much is already known. Dyer Jr and Wilkins (1991) then indicated that the number of cases and the length of the researchers' stay is not the key issue, but that the key issue is whether the researcher is able to describe and understand the context of the scene in question, so that the context can be made understandable to the readers and produce theory or theoretical propositions related to the context.

Linking back to this thesis, Shenyang's urban housing can be viewed as a large single-case with three embedded units: urbanisation, housing demand and housing densification. There are several reasons for this. First, this case is critical to the theoretical proposition that rapid urbanisation leads to increasing housing demand, which results in housing densification. Separately, each unit has its own theory or theoretical proposition, as discussed in the literature review. Second, each embedded topic can capture the circumstances and conditions of urbanisation, housing demand and housing densification, or discover some unusual phenomena for each embedded topic. Third, through the analysis the thesis will provide conclusions for Shenyang's urban housing and recommend policy suggestions for each topic. Fourth, in order to describe and specify the processes of each topic and how they change over time, the thesis studies the case in a certain period of time[29], which responds to the fifth rationale, *longitudinal*, of a single-case study. Thus, according to those discussions, this thesis applies case study as a research methodology, and it is considered as a single case study with three embedded units: urbanisation, housing demand and housing densification.

4.3. Theoretical base of methods

4.3.1. Philosophy of regression analysis

Regression analysis is a powerful statistical method to examine the relationship between two or more variables of interest. The philosophy of regression analysis can be interpreted by the empiricism philosophy[30] in science research. For the empiricist interpretation, regression analysis is considered as a formal method, and the regression equation has the form of a general law. It is a quantitative research method used to test the nature of relationships between a dependent variable and one or more independent variables. As the use of the statistical model is justified in such way, the question of what is the philosophical status of this general law arises. Ron (2002) suggests two approaches to answer this question from an empiricist perspective. The first approach is structured as followed:

[29] For each embedded topic, the researcher selected a research period that covers more than two points of time. The details are displayed in the method and data issues sections.

[30] Empiricism is the philosophical tradition that understands scientific laws as a description of relations between sense observations expressed as constant conjunctions of events.

1. Scientific laws are expressed in terms of relations between observations, in the form of $y = f(x_n)$.
2. Regression analysis rests on a mathematical theorem that assumes the existence of a true model, in the form of $y = f(x_n)$.
3. Social relations cannot be modelled in such a way, either for epistemological or for ontological reasons.
4. Hence: regression analysis cannot be used for a causal inference but only for a descriptive inference.

This approach is designed to frame the answer in terms of a continuum between a 'mere description' and a 'true model'[31], and statistical models are used to estimate the parameters of the function in a known level of precision based on data taken from a sample. For example, ordinary least squares (OLS), as the most basic and widely used form of regression analysis, allows an estimation of the parameters of a model, assuming that there are linear relations between the variables. This approach to answer the question of the metaphysical status of the regression equation is to claim that it is an attempt to estimate a true model that exists in the real world. There are two assumptions that must be sustained in order to ensure the result of a regression analysis is an estimate of a true model. The first is an ontological assumption that social relations are modelled in a way that can be described as a mathematical function. The second is an epistemological assumption that it is possible to know the parameters of this function. Both assumptions are difficult to sustain. First, for the ontological assumption, there is no procedure that can be used to support or refute it, as social relations are modelled by a true model that is still unknown to us. Second, for the epistemological assumption, even if it is believed that social relations follow a law-like mathematical function, the current status in the social science provides few clues regarding the form of this function (Ron, 2002).

Considering the two difficult-sustained assumptions, Ron (2002) provides the second approach from the empiricist perspective. The second approach is similar to the first approach but constructs competing models to explain the same research process, because for epistemological reason we cannot know the functional form of the 'true model'. Ron (2002) also indicates that the way that the competing models can explain the relationships

[31] The term 'true model' appears in the statistical model upon which regression analysis is based. The true model is a mathematical function that connects the variables in a population.

between variables is by collecting sufficient empirical observations. Hypothetically, if it could collect all available data, the 'true model' will be the one that best fits the data for the research. However, in the most research, as it only collects a sample of observation, not all the observations, it is not possible to use 'goodness of fit' as the only criterion to distinguish between the models. Hence, additional criteria or further explanations should be used to distinguish and discuss between the competing models, in order to ensure the empirical adequacy. Ron (2002) divides the additional criteria and further explanations into three groups. The first group is to add a different criterion for explanation, usually expressed in terms of models, theories, or causal mechanisms. The second group is to add personal knowledge, beliefs and needs of the scientist, so that the best explanation is the one that conforms with the pre-existing knowledge or is suitable for the needs. The third group is to add a different empirical criterion to select between models, which different methods of robustness check may be used in addition to the criterion of goodness of fit.

Linking to this thesis, the literature review shows that many studies use regression analysis to research urbanisation and housing demand, e.g. Mills et al. (1986), Mills (1972), Henderson (2000), Henderson (2003) and Zhang (2002) for urbanisation, and e.g. Muth (1960), Carliner (1973), Malpezzi and Mayo (1987) and Chow and Niu (2010) for housing demand. All of those studies are based on the empiricist sense to examine the relationship between the variables and estimate the parameters of the function in a known level of precision based on data taken from a sample, which provide an inspiration for this thesis to analyse urbanisation and housing demand using regression analysis in the empiricist perspective. Furthermore, due to data availability, it is impossible to collect all data of empirical observations but a sample of observations, so additional criteria that consider both stable and lagged situations will be used to distinguish between the competing models, in order to ensure the empirical adequacy.

4.3.2. Multiple regression analysis with time series data

Theoretically, multiple regression is often used for two main purposes: first, it can be used to predict a dependent variable using a combination of independent variables; second, it can be used to estimate whether one variable affects another causally and the magnitude of the effect (Remler and Van Ryzin, 2010). Multiple regression analysis is most useful for ceteris paribus analysis because it can control many other factors that simultaneously affect the dependent variable. It is important for testing economic theories and evaluating

policy effects when we must use non-experimental data (Wooldridge, 2015). Another advantage of using multiple regression is that it can accommodate many independent variables that may be correlated, and this is better for inferring causality than simple regression. Moreover, multiple regression can incorporate general functional form relationships, and this is more flexible than simple regression where only one function of a single variable appears in the equation (Wooldridge, 2015).

A widely used method of multiple regression for the urban economy is the Ordinary Least Square (OLS) method, which estimates the parameters of a multiple linear regression model (Wooldridge, 2015). The OLS method is often used when both the independent and dependent variables are quantitative and continuous (Remler and Van Ryzin, 2010). The OLS method can describe a regressed relationship between the independent and dependent variables through a linear equation. This linear equation provides a line called the OLS regression line, and all the data are located on or around this line. Two things are essential for the OLS method: goodness-of-fit and residuals.

Goodness-of-fit refers to how well the independent variables explain the dependent variable, which is represented by R-square (Remler and Van Ryzin, 2010, Wooldridge, 2015). Generally, a higher R-square (close to 1) is better for prediction and explanation, because it provides a tighter fit for the data and fewer errors. However, depending on the real situation and availability of data, it does not need to be near perfect (Remler and Van Ryzin, 2010).

Residuals are the difference between the actual value and the fitted value, or the unexplained variation not in R-square. Goodness-of-fit and residuals can be explained: if all the data were perfectly regressed, they would all be located on the line. In this case, R-square would be 1 and residuals would be 0 (Remler and Van Ryzin, 2010). However, in real situations, two figures are not that perfect, especially in social science. Sometimes, low R-squares are common (Wooldridge, 2015).

Time series data and cross-sectional data are the two main types of data in econometrics. Compared to cross-sectional data, time series data follow a temporal ordering (Wooldridge, 2015). According to the research design, this thesis aims to investigate urbanisation and housing demand, focusing on how their influencing factors work over a certain period of time. With these research aims, time series analysis with time series data is chosen for the two embedded units.

With the application of the OLS method with time series data, the randomness of samples must be ensured. Wooldridge (2015) indicates that economic time series data meet the intuitive requirements for the randomness of a sample because it is not possible to know the next time point's data until that point in time. Wooldridge (2015, p.313) also explains the randomness of samples for time series data: "Formally, a sequence of random variables indexed by time is called a stochastic process or a time series process … this is why we think of time series data as the outcome of random variables".

In time series, two models are prevalent and useful: **static models** and **finite distributed lag models**.

Static models

Static models analyse a contemporaneous relationship between a dependent and independent variable:

$$y_t = \beta_0 + \beta_1 x_t + \mu_t \tag{4.1}$$

Generally, a static model is postulated when a change in x at time t is believed to have an immediate effect on y ($\Delta y_t = \beta \Delta x_t,$ when $\Delta \mu_t = 0$). Static regression models are also used to analyse the trade-off relationships between y and x, and the models are also available and useful for multiple regression analysis (Wooldridge, 2015).

Finite distributed lag models

Finite distributed lag (FDL) models allow independent variables to affect a dependent variable with time lags; here is an example of an FDL model of order two:

$$y_t = \alpha_0 + \beta_0 x_t + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \mu_t \tag{4.2}$$

Under the situation of ceteris paribus effect of x on y, there is no error term (μ) in each period. In the above equation, there can be immediate changes between each time point, called impact propensity or impact multiplier. Similarly, there can also be changes between interval time points. The changes can be drawn as a function of time lag called lag distribution (Figure 4.2). The lag distribution implies that the largest effect occurs at the first lag (Wooldridge, 2015). Generally, the purpose of an FDL model is to test whether x has a lagged effect on y, and the models are available for multiple regression analysis (Wooldridge, 2015). Moreover, static models can be treated as a particular case

of FDL models with immediate changes between each time point set as zero (Wooldridge, 2015).

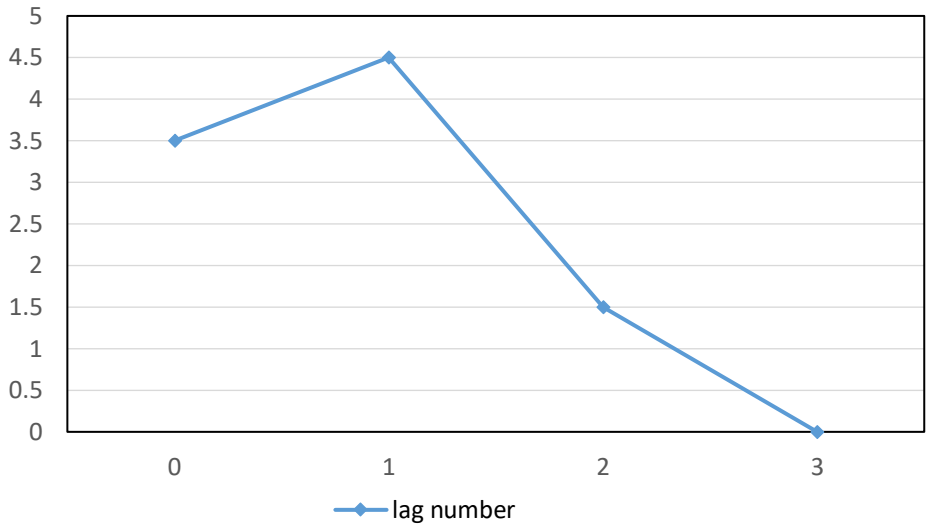


Figure 4.2 A lag distribution with two non-zero lags

Source: Wooldridge, 2015

4.3.3. Method of measuring housing density and changes

According to the literature review on different housing density measures, building coverage ratio (BCR) and floor area ratio (FAR) can be used for in-depth density analysis, rather than net density and gross density, because they take house size and three-dimensional building growth into account. Furthermore, for the current Chinese circumstances, the size of the house is much more commonly used than the number of houses, although both can explain housing quantity. There are two reasons for this: first, China's cities have larger urban populations than most other countries, and most of the population resides in high-density urban areas; second, in order to provide residential space for such a substantial urban population in relatively limited urban areas, medium-rise and high-rise residential blocks are constructed, so that vertical density cannot be ignored. Thus, BCR and FAR are selected as the housing density measures for this thesis.

The thesis will also introduce the average number of storeys (L) to represent the building height. In the study of Pont and Haupt (2010), BCR and FAR are used to represent the coverage density (two-dimensional space) and the building intensity (three-dimensional level) for residential communities in The Netherlands. Then the ratio of the FAR and

BCR represents the average number of storeys (L) for the community, because FAR and BCR share the same surface area of land. If more floor area is developed in a particular area, without changing the footprint, L will increase. If the building height remains constant, BCR and FAR have to increase. Thus, for this thesis, L not only represents the building height but also helps to reflect the vertical changes in housing density.

Besides analysing those measures for a certain time point, the changes in those measures within a time period are also chosen to describe and analyse Shenyang's housing density. The reasons include: first, housing density changes can demonstrate distinctly residential dynamics, which could influence densification inside urban areas and expansion outside urban areas (Broitman and Koomen, 2015); secondly, according to *Shenyang Urban Overall Development Proposed Plan 2011–2020*, Shenyang plans to limit the residential land-use inside the urban core. It also plans to increase the residential land-use in order to build several sizeable residential development zones outside the urban core (Shenyang Planning and Land Source Bureau, 2013). The residential purpose of the plan is to adjust the layout of residential land and to guide the residential population towards choosing a housing location outside the urban core, in order to relieve the housing pressure in the urban core. This proposal will result in significant changes to housing densities both inside and outside the urban areas. Thus, for these reasons, density measures are important for this investigation and analysis.

Broitman and Koomen (2015) introduce three different measures to describe the changing processes of housing density. The measures are based on the assumption that there is a change (ΔN**)** in the existing housing unit stocks (N_0**)** during a period (T_0 to T_1) in a particular area. Since housing construction and demolition can occur simultaneously, ΔN can be larger, equal to or lower than zero. The changes in housing unit stocks may occur either in the existing area (S_0) or outside area (S_{out}). Broitman and Koomen (2015) define the changes in housing unit stocks (ΔN_{in}) within S_0 as housing densification and changes in housing unit stocks (ΔN_{out}) within S_{out} as housing expansion. The total change (ΔN**)** is equal to the sum of (ΔN_{in}) and (ΔN_{out}). Figure 4.3 demonstrates the definitions of the measures and the situation where densities decrease from the urban centre outwards, based on traditional urban economics.

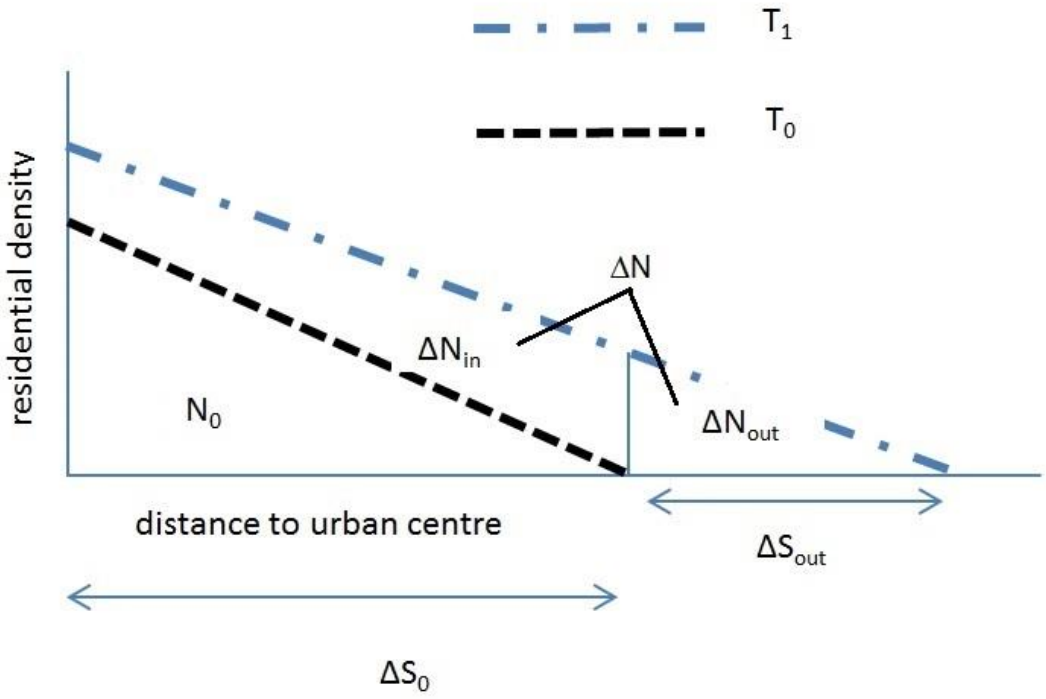


Figure 4.3 Housing density changes between T_0 and T_1

Source: Broitman and Koomen, 2015

Based on the schematic explanation, Broitman and Koomen (2015) define three measures of housing density, as follows:

1. *Densification share* ($\Delta N_{in}/\Delta N$): net increase in housing units or residential densification within a case-study area during the period of [T_0, T_1]. This can be expressed as the percentage of the housing unit increase within the case-study area (ΔN_{in}) to the total housing unit increase within and outside the case-study area (ΔN).
2. *Density increase* ($\Delta N_{in}/N_0$): in the case-study area, a residential density increase during the period of [T_0, T_1] can be defined as the percentage of the housing unit increase within the case-study area (ΔN_{in}) to the initial housing units (N_0). Residential density is defined as the percentage of housing units to the surface area of the urban area, while ΔN_{in} and N_0 share the same surface area of the urban area. Thus, this percentage of the housing unit increase can also express the percentage of the residential density increase.

3. *Expansion density* ($\Delta N_{out}/S_{out}$): beyond the boundary of the case-study area, newly built housing units are considered to be a kind of urban expansion. The average residential density beyond the boundary of the case-study area during the period of [T_0, T_1] can be defined as the percentage of the housing unit increase outside the case-study area (ΔN_{out}) to the surface area of these housing units (S_{out}).

These three housing density measures focus on housing units rather than housing space. Compared to developing countries, The Netherlands has a smaller population with a greater preference for single-family housing. In the Chinese circumstances, housing space is widely used rather than housing unit, as mentioned above, so housing space can be used instead of housing unit for the three housing density measures proposed by Broitman and Koomen. Thus, BCR and FAR can explain housing density, focusing on two-dimensional and three-dimensional spatial level, respectively.

4.4. Model estimations

4.4.1. Urbanisation model estimations

4.4.1.1. Static model estimations

The literature review revealed that urbanisation is a consequence of economic development and can be driven by economic measures. This leads to the idea that we can use economic indicators as variables to test how they influence urbanisation. Mills et al. (1986) regressed an empirical linear model between urbanisation and its economic drivers, including GDP, employment and time trends. The equation is as follows:

$$U_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 A_t + \alpha_3 T_t + \mu_t \quad (4.3)$$

Where,

U_t: urbanisation rate at time point t

Y_t: GDP per capita at time point t

A_t: share of industrial and service employment at time point t

T: time trend

μ_t: stochastic disturbance term

Following the studies of Mills et al. (1986), Zhang (2002) regressed an empirical linear model for China's urbanisation, and the variables included GDP, employment, time trends and foreign direct investment. Following the method by Mills et al. (1986) and Zhang (2002), the hypothesis of a relationship between urbanisation and economic development plus real estate or housing investment for this study can be estimated as a linear regression model, as follows:

$$U_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 A_t + \alpha_3 I_t + \alpha_4 T_t + \mu_t \quad (4.4)$$

Where,

U_t: urbanisation rate at time point t

Y_t: GDP per capita at time point t

A_t: share of industrial and service employment at time point t

I_t: annual investment at time point t

T: time trend

μ_t: stochastic disturbance term

Because housing investment is subject to real estate investment, two items of investment cannot be estimated in one regression model if we are to follow the *Assumption of No Perfect Collinearity*, which is the general assumption of time series regression applications (Wooldridge, 2015). Thus, real estate investment and housing investment are incorporated into two separate equations, as follows:

$$U_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 A_t + \alpha_3 REI_t + \alpha_4 T_t + \mu_t \quad (4.5)$$

Where,

REI_t: real estate investment at time point t

And,

$$U_t = \alpha_0 + \alpha_1 Y_t + \alpha_2 A_t + \alpha_3 HI_t + \alpha_4 T_t + \mu_t \quad (4.6)$$

Where,

HI_t: housing investment at time point t

The urbanisation rate (U) is selected as the dependent variable. This variable is chosen as a proxy for increasing urban development and urbanisation for Shenyang. The independent variables in the model include GDP per capita (Y), the share of industrial and service employment (A), and the time trend (T). According to basic economic theory, because for the most part industrial output is sold outside the urban area where it is produced, it influences but is not influenced by the urban population. Employment in industry and services influences the size of the urban area and the urban population. Thus, industrial output (GDP in this research) and employment in industry and services are desirable independent variables in the regression. In Mill's model, the share of agricultural employment was selected to measure the labour force in industry as an independent variable, because the inclusion of the agricultural employment share is equivalent to the inclusion of the sum of the industrial and service employment share.

Many economic time series have a common tendency over time, and it is necessary to consider the impact of a time trend to draw a causal inference (Wooldridge, 2015). If the fact that two time series are trending in the same or opposite directions is ignored, one may falsely conclude that changes in one variable are actually caused by changes in another variable. In some cases, two time series appear to be correlated because they are both trending through time but there is no causal relationship between them (Wooldridge, 2015). It is generally believed that developing countries are urbanising faster than the economic development speed, and thus they are becoming over-urbanised. If this is true, time should be correlated with urbanisation, and it may capture the effects of an upward trend in urbanisation (Mills et al., 1986, Zhang, 2002). Thus, a time trend is introduced into the regression model.

Moreover, in the case of Shenyang, the annual real estate investment (REI) and annual housing investment (HI) are introduced into the model respectively as additional independent variables, based on the hypothesis that housing investment leads to urbanisation.

4.4.1.2. Lagged urbanisation model estimation

There are arguments for including lagged urbanisation in the regression model (Mills et al., 1986). If the equilibrium of urbanisation (U^*) depends on the variables, according to the static models mentioned previously, named as a function $f(\ )$, it follows that:

$$U^* = f(\ ) \tag{4.7}$$

Mills et al. (1986) stated that "Adjustment of the population to changes in variables affecting equilibrium urbanisation takes time, as major migration decisions may be involved". The most common assumption about such disequilibrium adjustments is modelled including a distributed lag, as follows:

$$U_t = U_{t-1} + \lambda(U^* - U_{t-1}) \tag{4.8}$$

Where (U_t) is the urbanisation rate at time t and (U_{t-1}) is its one-period lag. Equation (4.8) means that (U_t) equals its lagged value plus a fraction λ of the difference between the equilibrium and lagged value. If λ equals 0, (U_t) equals (U_{t-1}) regardless of equilibrium (U^*). If λ equals 1, (U_t) equals (U^*) regardless of (U_{t-1}). Thus, λ is expected to be between 0 and 1. Substitution of equation (4.7) into (4.8) gives the following:

$$U_t = \lambda f(\ ) + (1 - \lambda)U_{t-1} \tag{4.9}$$

Where,

U_t: urbanisation rate at time point t

U_{t-1}: urbanisation rate at time point t-1

U^*: equilibrium urbanisation rate

λ: annual percentage rate at which actual urbanisation rate converges to the equilibrium rate

Then,

$$U_t = \lambda(\alpha_0 + \alpha_1 Y_t + \alpha_2 A_t + \alpha_3 HI_t + \alpha_4 T_t) + (1 - \lambda)U_{t-1} + \mu_t \tag{4.10}$$

Where,

U_t: urbanisation rate at time point t

Y_t: GDP per capita at time point t

A_t: share of industrial and service employment at time point t

HI_t: annual housing investment at time point t

T: time trend

U_{t-1}: urbanisation rate at time point t-1

μ_t: stochastic disturbance term

The above model estimations for the urbanisation are based on the economic concerns. Moreover, apart from the economic factors involved in the urbanisation dynamics, social motivations for migration also need to be considered, even if they are not included in the economic models. Courgeau and Lelièvre (2006) indicates that social motivations for migration cause individuals to stay in the same place or to change their residential locations, and the reasons that cause those individuals to move can be understood when related to their past experience and present circumstances. In the Chinese context as discussed in the introduction and background, the *hukou* status are important to migrants, which ensure them to enjoy the equal social welfare and urban benefits as the urban residents (Fan, 2008). The *hukou* status with its provident social welfare and benefits is considered as a main social motivation to attract migrants to move to cities, even though it needs rigid eligibility criteria and takes time on applications, resulting in the gap of resident population and population with the *hukou* status (Chan and Zhang, 1999, Fan, 2008). Thus, apart from estimating the urbanization models with the economic variables, the thesis also provides analyses and further discussions on Shenyang's migration and the impacts of the *hukou* system on the migration.

4.4.1.3. Model specification

According to the model estimations above, the urbanisation models for the thesis consider both static and one-time lagged situations, with the involvement of real estate investment and housing investment separately. In order to analyse and understand each model situation, the model specification has four steps, as follows:

step (1) Using Equation (4.3) to estimate the relationship between urbanisation (U), GDP per capita (Y) and employment share of industrial and service (A), in order to test whether the basic urbanisation model works in Shenyang's case.

step (2) Using Equation (4.5) to estimate the relationship between urbanisation (U), GDP per capita (Y), employment share of industrial and service (A), and annual real estate investment per capita (REI), in order to test whether real estate investment can drive urbanisation significantly.

step (3) Using Equation (4.6) to estimate the relationship between urbanisation (U), GDP per capita (Y), employment share of industrial and service (A), and annual housing investment per capita (HI), in order to test whether housing investment can drive urbanisation significantly.

step (4) Using Equation (4.10) to estimate the urbanisation that is not in equilibrium, adding one time lag urbanisation variable (U_{t-1}), in order to test whether the lagged urbanisation model with housing investment works in Shenyang's case.

4.4.2. Housing demand model estimations

4.4.2.1. Basic model

According to the literature review, the theory of consumer behaviour indicates that housing demand should be a function of people's income and housing prices. According to this viewpoint, a basic housing demand model can be written as follows:

$$S_t = \alpha_0 + \alpha_1 I_t + \alpha_2 P_t + \mu_t \tag{4.11}$$

Where,

S: housing demand

I: income

P: housing prices

μ_t: stochastic disturbance term

In housing demand studies, housing demand can be identified by housing space or housing consumption. If housing demand is identified by housing units, the housing demand function reflects household formation decisions as well as tenure choice. Alternatively, if housing demand is identified by housing consumption, the housing demand function combines decisions about not only household formation and tenure choice but also the consumption of housing services (DiPasquale and Wheaton, 1994). Chow and Niu (2010) used housing space per capita to identify housing demand in order to analyse residential housing in China, which could avoid the scale effect of an increase in population in the Chinese context. Chow and Niu also stated that doubling the size of the population would be expected to double the housing demand. Because housing space per capita is an average value, the result would be explained as an average demand by

mean income and prices. Thus, this study will apply housing space per capita to identify housing demand for the case of Shenyang.

Through the literature review, it was identified that two types of income data are commonly used in housing demand models: current income and permanent income. De Leeuw (1971) indicated that using current income could yield a higher elasticity than using permanent income. Choosing an appropriate measure of income for housing demand models also depends on the method and data. For the case of Shenyang, the study is based on a twenty-year time series of annual data, so current income is appropriate for the analysis. Housing prices in this study follow Chow and Niu (2010), using relative price, which equals current housing price divided by CPI. The reason for dividing by CPI is to avoid inflation effects, and the details of this will be presented in **Section 4.5.2**.

4.4.2.2. Demographic factors involvement

According to the literature review, demographic and economic factors are two of the main factors that directly influence housing demand. Skaburskis (1997) indicated that demand for housing units was affected by population size and by the manner in which the population was divided into households. Thus, for this research, population and household size will be introduced into the housing demand model.

In Equation (4.11), the dependent variable (S) denotes housing demand, i.e. housing space per capita on average, which is calculated as follows:

$$S = H/POP \tag{4.12}$$

Where,

S: housing space per capita

H: total housing space

POP: total population

Because population is already included in the equation, there is no need to set another independent variable of population.

The household size for this research is an average value for the whole city during the research period, which is calculated as follows:

$$HS = POP/NH \quad (4.13)$$

Where,

HS: household size on average

POP: total population

NH: number of households

4.4.2.3. Location and commuting expenditure involvement

According to the literature review, spatial locations affect a household's housing decisions, and commuting costs in accessibility costs are a large part of a household's budget and therefore also affect housing choice for households. Alonso (1964) assumed that an individual's expenditure normally included land costs, commuting costs and all other expenditure. Because the expenditure should be equal or less than the individual's income, assuming that the equilibrium of expenditure is equal to income, Alonso (1964) estimated a budget equation, as follows:

$$\mathrm{y} = p_{\mathrm{z}}\mathrm{z} + P(t)q + k(t) \quad (4.14)$$

Where,

y: income

p_z: price of the composite good

z: quantity of the composite good

$P(t)$: price of land at distance t from the centre of the city

q: quantity of land

$k(t)$: commuting costs to distance t

t: distance from the centre of the city

In this equation, there are three variables: (z), (q) and (t). If the composite good is held constant at $(z = z_0)$, and we allow (q) and (t) to vary, equation (4.14) can be written as:

$$\mathrm{y} = p_{\mathrm{z}}z_0 + P(t)q + k(t) \quad (4.15)$$

Also, it can be written as:

$$q = [y - p_z z_0 - k(t)]/P(t) \quad (4.16)$$

From Equation (4.16), we can see that the price of land (P) decreases with increasing distance (t) from the city centre. Therefore, the quantity of land (q) increases with distance, since land is becoming cheaper. On the other hand, commuting costs (k) increase with increasing distance (t), and consequently the land quantity (q) that may be bought decreases. Therefore, distance has a negative relationship with land quantity. For this research, the data of distance from the city centre for individuals or households are not available, and the study therefore focuses on the average value of the variables for the city. Thus, commuting costs and housing prices can be considered as independent variables without distance concerns.

As Equation (4.16) reflects the individual aspect of land purchase, land quantity here can be assumed to be housing demand per capita. Similarly, land price can be considered to be housing price. From the equation, commuting costs are assumed to have a negative relationship to housing demand per capita. Thus, it is appropriate to add commuting expenditure (C) as an explanatory variable in the housing demand models.

4.4.2.4. Other factors involvement

Renting is another way of owning housing in a certain period. If the quantity of housing demand is more than the quantity of housing supply less the normal level of vacancies, the housing market will break the equilibrium. If the housing supply cannot match the housing demand, people will be able to rent housing at appropriate prices. Rental costs have been mentioned as a variable for housing demand models in many housing studies. Thus, this research will introduce rents (R) as an explanatory variable into the housing demand models.

Besides rental costs, residential energy use is also connected to housing consumption, as bigger houses generally consume more energy for cooling and heating. For households, residential energy expenditure increases with increasing energy uses, which will influence housing choices for households. Thus, energy consumption is assumed to affect housing demand per capita, and energy expenditure per capita (E) will be introduced into the housing demand model as an explanatory variable.

In the Chinese context, the data on rental costs and energy expenditure were not collected or recorded in the statistical yearbooks, so this data were not available to set rents (R) and energy expenditure (E) in the housing demand model. Instead, in the statistical yearbooks, residential expenditure covers rents and energy expenses, which refers to expenditure related to residence, including housing rents, water, electricity, fuel, property management, and converted self-owned housing rents (National Bureau of statistics of China, 2017). Thus, residential expenditure(RE) can be set as an alternative explanatory variable instead of rents (R) and energy expenditure (E).

Considering the economic, demographic, locational and residential factors, the housing demand model for the case of Shenyang is estimated as a linear equation, as follows:

$$S_t = \alpha_0 + \alpha_1 I_t + \alpha_2 P_t + \alpha_3 C_t + \alpha_4 HS_t + \alpha_5 RE_t + \mu_t \quad (4.17)$$

Where,

S: housing space per capita

I: income

P: housing prices

C: commuting expenditure

HS: household size

RE: residential expenditure

μ_t: stochastic disturbance term

4.4.2.5. Partial adjustment process

Equation (4.11) and Equation (4.17) assume that the housing market is in equilibrium all the time, that the housing market clears quickly, and that at any time, housing prices adjust

to equate the housing demand with the existing housing stock. Thus, the price variables in these two equations refer to the equilibrium price (DiPasquale and Wheaton, 1994, Chow and Niu, 2010). However, most practical situations provide evidence that the demand side of the housing market does not clear quickly. According to DiPasquale and Wheaton (1994, p.6):

> The fact that housing prices are incomplete predictors of new housing construction, and the observation that vacancy rates generate gradual price changes, and the observed tendency for positive serial correlation in housing prices all can be explained if housing prices adjust only gradually over a number of periods in response to shocks.

This statement implies that housing stocks clear slowly in the market, and due to product heterogeneity and time-consuming searches, the sales time for housing is unpredictable. Individual sellers cannot easily determine if an overly long sales time implies a decline in the market or a random misfortune. Considering these points, rapid price adjustments may not be rational, and gradual price adjustments should be considered (DiPasquale and Wheaton, 1994).

Following DiPasquale and Wheaton (1994), in order to introduce a price adjustment mechanism, (P_t^*) can be set as a hypothetical equilibrium price at time point t, with τ as an annual percentage rate at which actual prices converge to the equilibrium price. The relationship between the actual price P_t and P_{t-1} at time point t and t-1 respectively is as follows:

$$P_t = \tau P_t^* + (1 - \tau) P_{t-1} \tag{4.18}$$

Where,

P_t: actual price at time point t

P_{t-1}: actual price at time point t-1

P_t^*: equilibrium price at time point t

τ: annual percentage rate at which actual prices converge to the equilibrium price

Then,

$$P_t - P_{t-1} = \tau (P_t^* - P_{t-1}) \tag{4.19}$$

Similarly, according to Chow and Niu (2010), a partial adjustment process can also be assumed for the actual housing stock (housing space per capita) (S_t) to adjust within a year by only a τ to its equilibrium level (S_t^*), as follows:

$$S_t - S_{t-1} = \tau(S_t^* - S_{t-1}) \quad (4.20)$$

Where,

S_t: actual housing space per capita at time point t

S_{t-1}: actual housing space per capita at time point t-1

S_t^*: equilibrium housing space per capita at time point t

τ: annual percentage rate at which actual housing space per capita converges to this equilibrium price

Then,

$$S_t = \tau S_t^* + (1 - \tau)S_{t-1} \quad (4.21)$$

As Equation (4.11) and Equation (4.17) represent housing demand (S_t^*) in equilibrium, we add them into Equation (4.21) respectively, as follows:

$$S_t = \tau(\alpha_0 + \alpha_1 I_t + \alpha_2 P_t) + +(1 - \tau)S_{t-1} + \mu_t \quad (4.22)$$

And,

$$S_t = \tau(\alpha_0 + \alpha_1 I_t + \alpha_2 P_t + \alpha_3 C_t + \alpha_4 HS_t + \alpha_5 RE_t) + (1 - \tau)S_{t-1} + \mu_t \quad (4.23)$$

Where,

S_t: actual housing space per capita at time point t

I: income

P: housing prices

C: commuting expenditure

HS: household size

RE: residential expenditure

S_{t-1}: actual housing space per capita at time point t-1

μ_t: stochastic disturbance term

Equation (4.11) and Equation (4.17) represent Shenyang's housing demand in equilibrium, and Equation (4.22) and Equation (4.23) represent housing demand with a partial adjustment process. These four equations will be regressed with a time series, which correspond to the four steps in **Section 4.4.2.6**.

4.4.2.6. Model specification

According to the model estimations above, the housing demand models consider both static and lagged situations. In order to analyse and understand each model situation, the housing demand model specification has four steps, as follows:

step (1) Using Equation (4.11), assuming that the housing market is in equilibrium, to estimate the relationship between housing space per capita (S), income (I) and housing prices (P).

step (2) Using Equation (4.22), considering a partial adjustment process on housing demand, to estimate the relationship between housing space per capita (S), income (I) and housing prices (P), and one-time lagged housing space per capita (S_{t-1}).

step (3) Using Equation (4.17), assuming that the housing market is in equilibrium, to estimate the basic housing demand model adding commuting expenditure (C), household size (HS), and residential expenditure (RE).

step (4) Using Equation (4.23), considering a partial adjustment process on housing demand, to estimate the basic housing demand model adding commuting expenditure (C), household size (HS), residential expenditure (RE), and one-time lagged housing space per capita (S_{t-1}).

4.5. GIS applications with spatial aggregation levels on housing densification

In **Section 4.3.3**, the thesis discusses the theoretical method of housing density and changes with the involvement of specific density measures BCR and FAR. This section will explain how these density measures can be applied with spatial aggregation levels for Shenyang's case.

Broitman and Koomen (2015) apply several spatial aggregation levels with increasingly smaller and finer units to analyse density changes across different scales. In their research, four spatial aggregation levels from coarse units to fine are applied: the first level is the coarsest regional level with 40 regions; the second level contains 76 regions that share similar housing market characteristics; the third level is based on the administrative borders of 443 municipalities; and the fourth level comprises the 4,003 postcode areas with a fairly homogeneous population and housing characteristics. This method not only expresses expansion density and impressive densification at various scale levels but it also reflects the related decision making of housing development (Broitman and Koomen, 2015).

The method used by Broitman and Koomen can describe changes in housing density quantitatively, and demonstrate graphically where the housing density changes, using GIS software, for a particular area during a defined period. Thus, as it focuses on urban housing for Shenyang, this research will apply spatial aggregation at three levels: the first level is a relatively coarse level covering the entire urban area of Shenyang, including 5 urban districts and 4 suburban districts; the second level focuses on the central urban core, including 5 central urban districts[32]; and the third level is a relatively fine level, focusing on each central urban district. A similar spatial aggregation method has been used by Li et al. (2012a) for the analysis of residential plot types and population densities.

According to Shenyang's spatial planning, the finest spatial unit is a land cell[33], and each land cell is nominated as a community in an urban area, or a village in a suburban or rural area, and given a code. In this way, Shenyang is composed of 2,584 land cells; the details of each spatial level are given in Table 4.2. The urban and suburban districts are illustrated in Figure 4.4.

[32] The central urban districts include Heping, Shenhe, Huanggu, Dadong, and a part of Tiexi. From the map, only about a quarter of the area of Tiexi district is located in the urban core, which is adjacent to Heping district and Huanggu district. The other part of Tiexi district expands to the suburban area, located between Yuhong district and Sujiatun district. Thus, according to its locational feature, Tiexi district is divided into a central urban core part (Tiexi A) and a suburban part (Tiexi B) for this research.

[33]In urban design, land cell refers to a piece of land with boundaries, and it also called as urban cell or urban block in some research that has associated information such as land-use, land value, and location attributes in the GIS system.

Table 4.2 Spatial aggregation levels of Shenyang

Spatial aggregation levels	**The number of land cells**
Shenyang	2,584
Entire urban area	1,520
Central urban core	545
Central urban districts	
Heping	103
Shenhe	109
Huanggu	124
Dadong	93
Tiexi A	116
Suburban districts	
Sujiatun	202
Hunnan	271
Shenbeixin	213
Yuhong	203
Tiexi B district	86

Source: Author's fieldwork in Shenyang Urban Planning Design & Research Institute in 2016

However, there are two adjustments to be made to this method before we introduce it to the case of Shenyang. First, the three measures by Broitman and Koomen have been used for the case of The Netherlands, which covers many cities and regions. The adjacent cities and regions have enough space for housing expansion, so expansion density can be calculated based on the clear outside area (S_{out}). However, for the case of Shenyang, the finest spatial aggregation level is composed of five central urban core districts, and these five districts border on each other (Figure 4.4). This will make it difficult to define expansion. For example, when we define expansion for Dadong, some expansions occur in the bordered Huanggu and Shenhe, and these expansions are also the densifications in their area. Thus, the measures of *densification share* and *expansion density* containing the definitions of the expansion area cannot be calculated.

Second, the three measures by Broitman and Koomen use the number of houses as a unit, which reflects indirectly the fact that single-family houses are the main housing form at the nationwide level in The Netherlands. This method suits a low-density situation on a large regional scale but it cannot reflect high-density housing development with a large proportion of medium-rise and high-rise housing. As mentioned earlier, using housing floor area as the unit can express and explain the high-density housing development of most Chinese cities. If we use floor area instead of the number of houses, the expression of the three measures is the same as the floor area ratio (FAR).

Therefore, for Shenyang's case, the research will calculate *density increase* with three spatial aggregation levels (the entire urban area, the central urban core and each urban district), with FAR as the unit. Moreover, the technique for calculating Shenyang's housing densification is based on the application of GIS software.

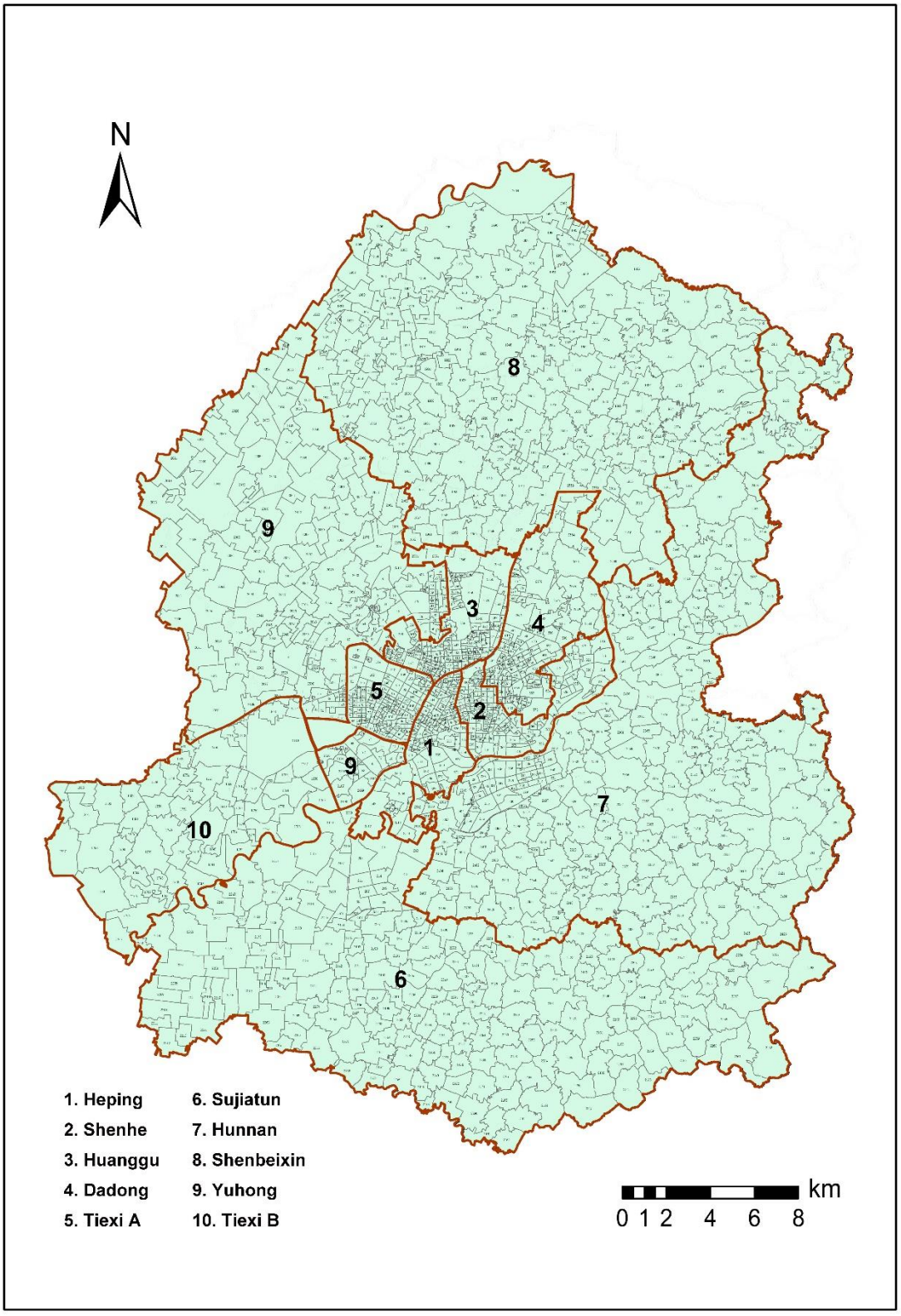


Figure 4.4 Map of the urban and suburban districts of Shenyang

4.6. Data issues

4.6.1. Data collections

4.6.1.1. Data of urbanisation

For this thesis, the urbanisation topic comprises analysis with time series data. According to the review of Chinese housing development in Chapter 2, after the 1990s. real estate development, with rapid economic growth, entered into a boom period, and housing as an essential section of the real estate also experienced rapid growth. *The Decision on Deepening the Urban Housing Reform* in 1994 provided a comprehensive framework of housing development for the coming years, which marked the start of housing reform in China. With the establishment of HPF in 1994, housing in China started to be marketised. Following the national reform, Shenyang experienced its first stage of housing development after 1995, as mentioned in Chapter 2. Thus, considering these events and housing investment as a hypothetical variable of urbanisation, the data for this section were selected for a twenty-year period from 1995 to 2014. According to the paper by Simonton (1977), arguably the minimum sample size of time series based on OLS regression is four, so the data satisfy the requirement of minimum sample size.

The data on Shenyang's urbanisation are taken primarily from the annual issues of the *Shenyang Statistical Yearbook*, including both book and online resources published by Shenyang Municipal Bureau of Statistics. The *Shenyang Statistical Yearbook* (years may vary) is a comprehensive and authentic annual databook. It presents Shenyang's social and economic development through accurate and reliable statistics. It is also an essential reference for the decision making of economic and scientific research for the city government. A detailed description of data resources for each variable is given in Table 4.3.

Table 4.3 Variables description and data sources for the urbanisation analysis

Variables	Descriptions	Data sources
Urbanisation rate (U)	Shenyang's urbanisation level by percentage, which equals urban population divided by total population.	*Shenyang Statistical Yearbook* 1996–2015 (book and online resources)
GDP per capita (Y)	Shenyang's real value of GDP per person, which equals real GDP divided by total population.	*Shenyang Statistical Yearbook* 1996–2015 (book and online resources)
The share of industrial and service employment (A)	Shenyang's local employment in industry and services by percentage, which equals employment in industry and services divided by total employment	*Shenyang Statistical Yearbook* 1996-2015 (book and online resources)
Annual real estate investment per capita (REI)	Shenyang's real value of annual real estate investment per capita, which equals real estate investment divided by total population. Real value requires data correction.	*Shenyang Statistical Yearbook* 1996–2015 (book and online resources)
Annual housing investment per capita (HI)	Shenyang's real value of annual housing investment per capita, which equals real estate investment divided by total population. Real value requires data correction.	*Shenyang Statistical Yearbook* 1996–2015 (book and online resources)

4.6.1.2. Data of housing demand

The housing demand for Shenyang takes a time series analysis. The research initially attempted to use a time series of quarterly and monthly data. However, the quarterly and monthly data are only available from 2005. In order to gain a convincing and associated conclusion for Shenyang's housing and urbanisation, it is better to apply the same research period of data for both topics. Besides, the quarterly and monthly data are incomplete and unfinished for some variables. Thus, this analysis applies a time series of annual data from 1995 to 2014 for the housing demand in Shenyang.

In this study, the housing market of Shenyang is treated as one market, although some variables like housing prices vary substantially in different urban districts. For example, the urban core districts (Heping, Shenhe, Dadong, Huanggu, Tiexi) have higher housing prices than the suburban districts (Yuhong, Sujiatun, Dongling, Xinchengzi) and the municipal counties (Xinmin, Liaozhong, Faku, Kangping). Thus, when we use a time series data to estimate the housing demand in Shenyang, our series is an average across different districts. This treatment does not only apply to the housing prices, but also to the housing stock, people's income and other variables.

The data for Shenyang's housing demand is taken from the annual issues of the *Shenyang Statistical Yearbook* including both book and online resources published by Shenyang Municipal Bureau of Statistics. A detailed description of the data resources for each variable is given in Table 4.4.

Table 4.4 Variable description and data sources for the housing demand analysis

Variables	Descriptions	Data sources
Housing space per capita (S)	Shenyang's residential housing space per capita (m^2).	*Shenyang Statistical Yearbook* 1996–2015 (book and online resources)

Income (I)	Disposal income per capita (yuan), which refers to people's income for the purpose of final expenditure and savings.	*Shenyang Statistical Yearbook* 1996–2015 (book and online resources)
Housing prices (P)	Annual housing prices on average (yuan/m^2), which equals the sale of housing sold divided by the floor space of housing sold.	*Shenyang Statistical Yearbook* 1996–2015 (book and online resources)
Commuting expenditure (C)	Expenditure on transport and communications per capita (yuan).	*Shenyang Statistical Yearbook* 1996–2015 (book and online resources)
Household size (HS)	Number of household members in a household on average, which equals the total population divided by the number of households.	*Shenyang Statistical Yearbook* 1996–2015 (book and online resources)
Residential expenditure (RE)	Expenditure including housing rents, water, electricity, fuel, property management, and converted self-owned housing rents (yuan)	*Shenyang Statistical Yearbook* 1996–2015 (book and online resources)

4.6.1.3. Data of housing densification

The housing densification of Shenyang focuses on the housing density. The research initially planned to collect data for the same period as urbanisation and housing demand, i.e. between 1995 and 2014. However, because the GIS database of urban planning data for Shenyang has been established in recent years, many housing data and related data

are not fully comprehensive or complete for the requirements of spatial aggregation levels. Thus, in order to meet the data requirements, the data for 2010 and 2014 were selected.

The data collection aims to gather the density data for all spatial aggregation levels (Table 4.2). It was conducted via a fieldwork in the Information and Data Centre of Shenyang Urban Planning Design and Research Institute in 2016, and the outcomes include data Excel tables and related GIS images. A detailed description of the data resources for each variable is given in Table 4.5.

Table 4.5 Data items and sources for the housing densification analysis

Data items	Descriptions	Data sources
	Housing density	
The area of building coverage	The area of building coverage of each land cell (m^2) in 2010 and 2014, respectively.	Shenyang Urban Planning Design & Research Institute
The total building floor area	The total building floor area of each land cell (m^2) in 2010 and 2014, respectively.	Shenyang Urban Planning Design & Research Institute
The land area	The land area of each land cell (m^2).	Shenyang Urban Planning Design & Research Institute

Besides the density data collection, the fieldwork conducted in Shenyang Urban Planning Design and Research Institute also includes some semi-structured interviews to the urban planners, in order to collect some general information about Shenyang's urban planning and urban development. In social science research, semi-structured interviews are commonly used in qualitative research and considered as the most frequent qualitative data source, and the overall purpose of this method is to gather information from participants who have personal experiences, attitudes, perceptions and beliefs related to the topic of research interest (Remler and Van Ryzin, 2010). This method typically consists of a conversation between researcher and participant, guided by a flexible interview protocol and supplemented by interview questions, probes and comments.

Compared with structured interview, semi-structured interview is more flexible and allows the researcher to concentrate on interviewee's perspectives (Remler and Van Ryzin, 2010). For this thesis, in order to realise the circumstances of the urban development and better design the case study, five semi-structured interviews were conducted during the fieldwork in Shenyang Urban Planning Design and Research Institute in July 2016. The semi-structured interviews are only used to prepare the case study for this thesis, which gather general information for designing the research framework and capture the key urban issues such as insufficient urban land-use and high-density living. In detail, the interviews were conducted in the meeting room, and each interview had only one interviewee. The average time of each interview was between 30 to 45 minutes. The interview questions are listed in Appendix 9.

Furthermore, in social science research, ethical issue is an essential aspect that must be considered by the researcher, and it involves undertaking responsibilities to all participants who take part in the research (Remler and Van Ryzin, 2010). There are four ethical principles in social science research: avoiding harm to participants; gaining informed consent; protecting privacy; and avoiding deceptions (Bryman, 2016). According to those four ethical principles, for this research, before the interviews the researcher made an appointment for each interviewee and made a brief introduction about the interview purposes and explains the interview questions, which allow the interviewees to decide if they would be willing to participate the interviews and when they would be free to take the interviews. During the interviews, the interviewees were free to share their views, and they were not pushed to reveal any information that they were not willing to share. All the interviewees' personal information, such as names, contact details, and positions, was not stored and did not appear in the thesis. Moreover, the ethical form and the informed consent of using GIS data are listed in Appendix 10 and Appendix 11.

4.6.2. Data adjustment

Before conducting the model tests, it is necessary to ensure the accuracy of the data used in the models. In this thesis, the data accuracy is influenced by inflation, so it is necessary to carry out data adjustment. Inflation is used to describe the process where the general price level is rising or losing value, and it becomes an essential and inevitable factor when comparing prices and costs measured by money units through time because the unit in which the value of resources is measured is also changing value simultaneously (Parkin et al., 1997). Due to inflation, it can be difficult to assess whether an increasing item represents an increasing trend in the real situation through a period, and it is also unclear whether differences in costs and prices reflect actual changes through a period (Kumaranayake, 2000).

Generally, there are two types of data: nominal data refers to money values of data that are not adjusted for inflation and real data refers to money values of data that are converted to one year's value (Wooldridge, 2015). In this research, the data on monetary value collected from *Shenyang Statistical Yearbook* is nominal data, so it is necessary to convert it to real data. The data that need adjusting include real estate investment, housing investment, housing prices, income, commuting expenditure and residential expenditure. For this thesis, the adjustment is the way in which real data equal to nominal data is divided by the urban CPI (Appendix 2.).

4.7. Chapter summary

This chapter explains the method used in each embedded unit of the thesis. For urbanisation and housing demand, the chapter first presents the theoretical base of the methods and techniques, including discussions on multiple regression with the OLS method and multiple regression with time series data. Then, the chapter presents the model estimations for both topics, considering both static and one-time lagged situations. For each model estimation, it starts from the basic model, and then develops with the involvement of the considered variables. For housing densification, the chapter first presents the theoretical base of housing density and changes with the selected density measures, and then explains the details of the application of spatial aggregation levels for Shenyang's case. For the data issues, the chapter presents the data collection methods for each topic and discusses the data adjustment for urbanisation and housing demand due to inflation.

The next three chapters will present the research results and analyse the results with further discussions for each topic.

5. Results and analysis of urbanisation in Shenyang

5.1. Chapter introduction

This chapter focuses on the research results for urbanisation. In order to achieve **RO3** of identifying the key factors that drive Shenyang's urbanisation, the chapter presents and discusses the urbanisation model results for Shenyang's case. In order to achieve **RO4** of explaining migration as the main reason for rapid urbanisation, the chapter discusses Shenyang's migration circumstances and how the *hukou* system works to control migration. In order to achieve **RO5** of investigating different sources of housing investment in Shenyang, the chapter discusses the main sources of housing investment and explains how they influence Shenyang's urbanisation.

5.2. Model results

First of all, this section lists a descriptive statistic for each variable in the models (Table 5.1). In order to reduce heteroscedasticity, all variables are taken as logarithms in the regression model. Table 5.2 presents a summary of all the model results. Table 5.3 presents the Granger causality test results, in order to explain the causal relationships between urbanisation, real estate investment and housing investment, respectively.

Table 5.1 Descriptive statistics of the urbanisation models

	Minimum	**Maximum**	**Mean**	**Std. Deviation**
U	-0.346	-0.324	-0.339	0.007
Y	1.740	2.144	1.965	0.105
A	-0.469	-0.324	-0.423	0.051
REI	1.260	1.750	1.573	0.159
HI	1.160	1.690	1.500	0.177
T	0.000	2.996	2.117	0.813

Table 5.2 Results summary of the urbanisation models

Variables	**Step (1)**	**Step (2)**	**Step (3)**	**Step (4)**
Y	-0.042***	-0.055***	-0.054***	-0.036***
	(0.007)	(0.010)	(0.010)	(0.011)
A	0.043***	0.029*	0.031*	0.008
	(0.013)	(0.014)	(0.015)	(0.015)
T	0.000	-0.002	-0.002	-0.003
	(0.001)	(0.001)	(0.001)	(0.001)
REI	-	0.010*	-	-
		(0.005)		
HI	-	-	0.008*	0.011**
			(0.006)	(0.005)
U (-1)	-	-	-	0.557***
				(0.201)
Constant	-0.239***	-0.230***	-0.230***	-0.086
	(0.011)	(0.011)	(0.012)	(0.087)
Adjusted R^2	0.934	0.942	0.939	0.958

Note: standard errors in parentheses. ***indicates significant at 1% level; **indicates significant at 5% level; *indicates significant at 10% level.

Table 5.3 Granger causality test statistic

Null hypotheses	**F statistic**
Real estate investment (REI) does not Granger-cause urbanisation (U)	17.679***
Urbanisation (U) does not Granger-cause real estate investment (REI)	5.096
Housing investment (HI) does not Granger-cause urbanisation (U)	29.063***
Urbanisation (U) does not Granger-cause housing investment (HI)	3.556

Note: Two lags are taken in each Granger test. ***indicates significant at 1% level.

5.3. Result discussions

Granger causality tests (Table 5.3) explain the causal relationships between real estate investment (REI) and urbanisation (U), and between housing investment (HI) and urbanisation (U). In detail, the null hypotheses that Shenyang's real estate investment and housing investment do not Granger-cause urbanisation are rejected at the 5 percent level of significance, as real estate investment and housing investment both Granger-cause Shenyang's urbanisation. On the other hand, the null hypotheses that Shenyang's urbanisation does not Granger-cause real estate investment and housing investment are not rejected at 5 percent level of significance, as both investments do not Granger-cause Shenyang's urbanisation. The Granger causality tests suggest the causal link between urbanisation and both types of investment, and they also prove the linear equations of setting urbanisation as the dependent variable.

In Step (1), the model estimates the empirical equation between urbanisation (U), GDP per capita (Y) and the employment share of industry and services (A) for the case of Shenyang. The fit of the model[34] is acceptable regarding adjusted R^2. First, GDP per capita (Y) is significantly and negatively correlated with urbanisation (U), suggesting that economic development has a negative effect on Shenyang's urbanisation. Second, the employment share of industry and services (A) is significantly and positively correlated with urbanisation (U), suggesting that shifts in the rural agricultural labour force into urban industry and the service sectors enhance Shenyang's urban growth. Third, the insignificant coefficient of the time trend (T) indicates that factors other than those included in the model contribute little to the upward trend in the urbanisation process and it provides some evidence against the over-urbanisation hypothesis (Mills et al., 1986). Therefore, the empirical equation fits for Shenyang's case due to the acceptable adjusted R^2 and the significant coefficients of the variables.

In Step (2), the model tests whether the real estate investment per capita (REI) drives urbanisation significantly. Compared to Step (1), the adjusted R^2 increases up to 0.942. First, GDP per capita (Y) and the employment share of industry and services (A) are

[34] In multiple regression, R-square is used to demonstrate the variation in the dependent variable predicted or explained by all the independent variables combined. Generally, a higher R-square (close to 1) is better for prediction and explanation, because it provides a tighter fit for the data and fewer errors. However, depending on the real situation and availability of data, it does not need to be near perfect (Remler and Van Ryzin, 2010).

significantly correlated with urbanisation at 1 percent level and 10 percent level respectively. Second, the real estate investment per capita (REI) is significantly and positively correlated with urbanisation at 10 percent level. Surprisingly, when adding real estate investment per capita (REI) as a variable, the significance of the employment share of industry and services (A) decreases. Through Step (2) it can be concluded that the real estate investment per capita (REI) drives urbanisation positively, and it also sets a precondition for Step (3) to test whether housing investment can drive urbanisation. The insignificant and negative coefficient of the time trend (T) also indicates some evidence against the over-urbanisation hypothesis.

In Step (3), the model tests whether housing investment per capita (HI) drives urbanisation significantly. The adjusted R^2 is 0.939. Overall, the result is similar to that in Step (2). As mentioned previously, housing investment is a big portion of real estate investment with a share of around 70 percent, with an increasing trend during the research period. This resulted in similar quantitative characteristics as in Step (2). Therefore, with an acceptable adjusted R^2 and significant coefficients, it can be concluded that housing investment per capita, GDP per capita and employment share of industry and services significantly drive urbanisation.

Step (4) introduces a lagged urbanisation into the model to test how this lagged urbanisation affects the model and whether housing investment can still influence urbanisation significantly. The adjusted R^2 reaches 0.958, which is the highest of all the regressions. First, GDP per capita (Y) is still significant at 1 percent level. Second, the employment share of industry and services (A) is not significant. Housing investment per capita (HI) is significant at 5 percent level and positively correlated with urbanisation. The lagged urbanisation (U_{t-1}) is significant at 1 percent level.

Overall, according to the results, GDP per capita (Y) is significant at 1 percent level to the urbanisation rate (U) for all the regressions, and real estate investment per capita (REI) and housing investment per capita (HI) are also significant at 10 percent level when they are involved. The results do not only support the viewpoint that the economy drives urbanisation, as mentioned in the literature reviews, but they also confirm that housing investment can drive urbanisation for Shenyang's case. Moreover, the regressions also provide the estimation for the relationship between the urbanisation rate and its influencing drivers. Considering housing investment as an influencing driver, it is difficult to choose between Step (3) and Step (4) regarding the sign and significance of

the coefficient. The two models explain the static and lagged situation for urbanisation respectively. The only apparent difference is that Step (4) has a larger adjusted R^2, which explains more of the sample variation of the urbanisation rate than Step (3). Mills et al. (1986) suggested that the choice of an appropriate regression model should depend on its detailed characteristics with regard to representing the urbanisation process.

Furthermore, the results show that GDP is negatively correlated with urbanisation in all the regressions, which is common in most developing countries in Asia and Africa. From the regression, the reason for this negative correlation might be GDP per capita that involves the impacts of the population, even though the total GDP keeps an increasing trend through the research period. This implies that Shenyang's economic is based on the labour-intensive industries rather than other industries. Turok and McGranahan (2013) also explain the reason for this negative relationship: because people leave rural areas due to poverty, migration to urban areas may undermine economic performance by creating undue congestions and diverting scarce public resources to fund social infrastructure. For this reason, the thesis will discuss Shenyang's migration circumstances in the next section.

5.4. Further discussions on urbanisation and housing investment

5.4.1. Urbanisation and migrations

Figure 5.1 presents the urbanisation rate of Shenyang City, Liaoning Province[35] and China between 2005 and 2014. Compared to the provincial and national level, Shenyang as the provincial capital city has a relatively high level of urbanisation – approximately 71 percent, and the level has kept on increasing since 2003. However, compared to the metropolitan areas of China, Shenyang has to go a long way to catch up. Figure 5.2 shows the urbanisation levels of Shenyang, Beijing and Shanghai. It is clear that there is a noticeable gap between Shenyang's urbanisation rate and that of Beijing and Shanghai, which have rates of approximately 85 percent and 89 percent respectively. For these ten years, the annual increase rate of Shenyang was about 1.33 percent, which is higher than the 0.32 percent of Beijing and 0.05 percent of Shanghai. Through the comparison, we can see that although Shenyang has a relatively low urbanisation rate compared to big cities, it has the capacity to grow with a relatively high increase rate.

[35] Because of the data availability and different statistical standards, the data on Liaoning's urban population was available for calculation from 2005 to 2014.

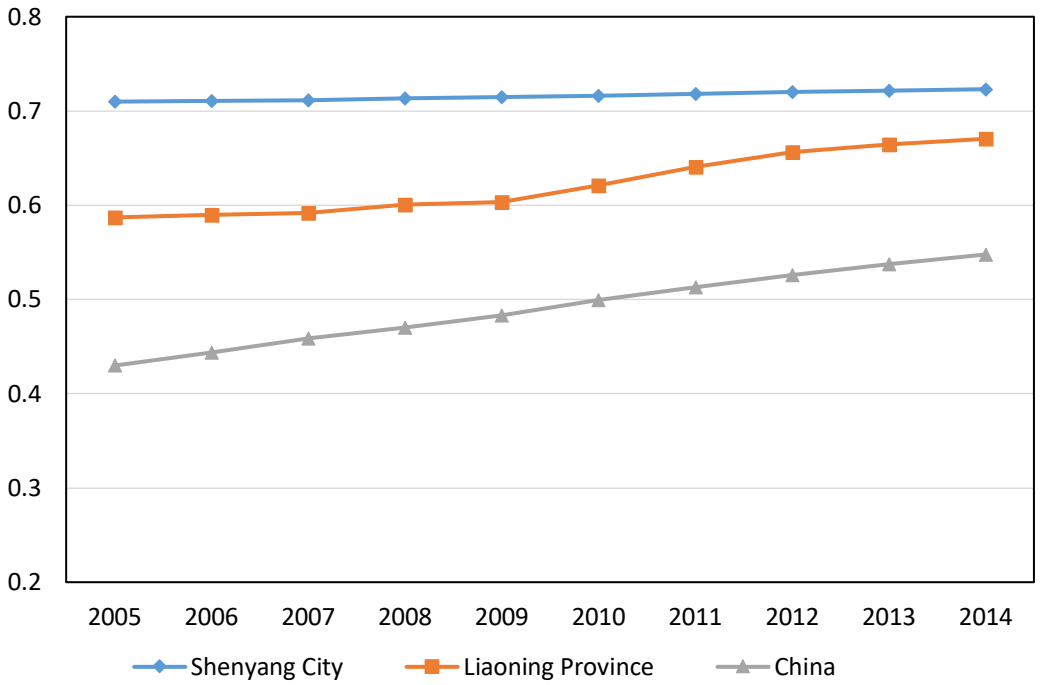


Figure 5.1 The urbanisation rate of Shenyang City, Liaoning Province and China 2005–2014

Source: Author's calculations based on *Shenyang Statistical Yearbook* (years vary) and *China Statistical Yearbook* (years vary)

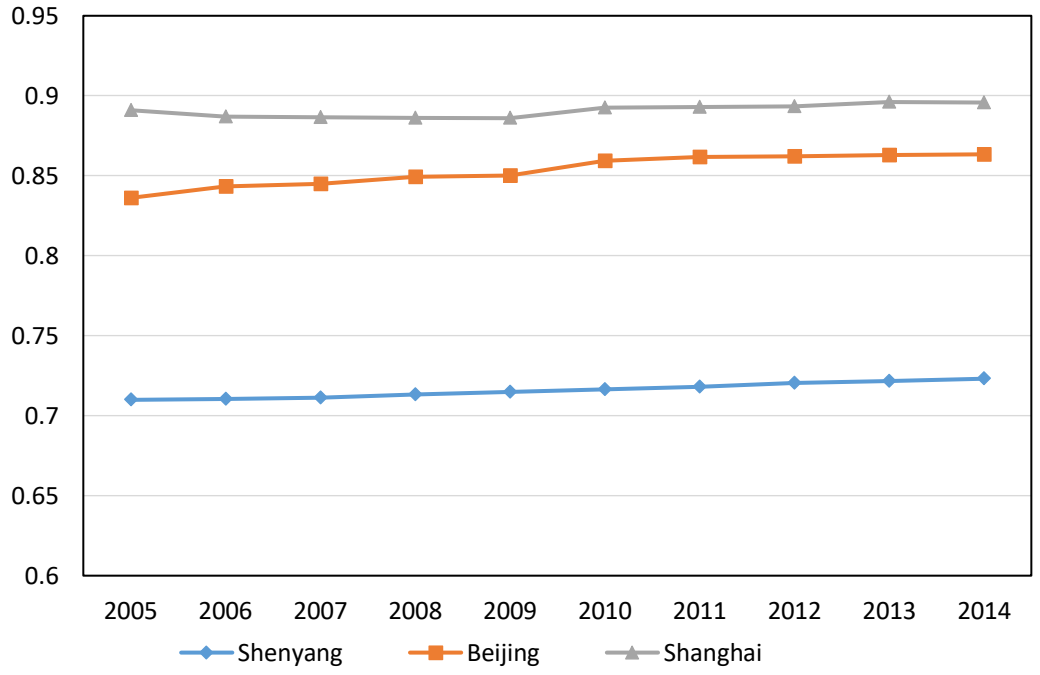


Figure 5.2 The urbanisation rate of Shenyang, Beijing and Shanghai 2005–2014

Source: Author's calculations based on the *China Statistical Yearbook* (years vary)

Behind the quantitative characteristics, it is necessary to discuss why the urbanisation rate has kept increasing in recent years. Apart from the direct economic factors demonstrated in the regression models, migration contributes substantially to the increasing urbanisation of Shenyang[36]. Figure 5.3 presents the quantitative situations of annual urban migration in Shenyang between 1995 and 2014. Even though the overall migrations have irregular fluctuations over time, in-migration and out-migration maintain similar patterns: in-migration increases or decreases when out-migration increases or decreases. This resulted in positive net migrations of between 20,000 and 45,000 annually, and the total net migration over this twenty-year period was 0.61 million. Such net migrations contributed to the increasing urbanisation rate through the period. This kind of migration-led urbanisation was prevalent in China after 1990, with the sharp increase in net migration from rural areas to major urban centres and new small towns (Chen et al., 2011a).

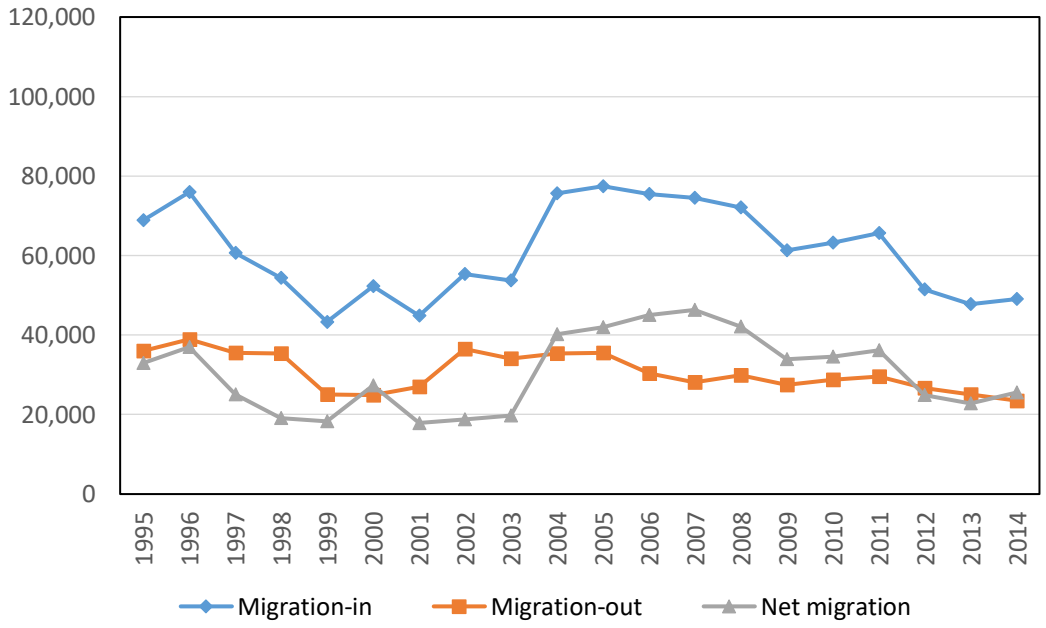


Figure 5.3 Annual urban migration descriptions of Shenyang 1995–2014

[36] Although natural growth of urban population contributes to increasing urbanisation mentioned in the literature review, it is necessary to compare the magnitude of natural growth of urban population and migration. Natural growth of urban population is the difference of birth and mortality. According to *Shenyang Statistical Yearbooks*, the net natural growth of urban population is much lower than the net migration, even no apparent growth and negative growth in some years. On average, the net migration is 30 times or more as much as the net natural growth of urban population. Thus, the influence of natural growth of urban population is negligible, and this section only considers that the migration contributes to the increasing urbanisation for the case of Shenyang.

Source: *Shenyang Statistical Yearbook* (years vary)

As known, since the reform and opening-up in 1978, in order to stimulate urban development, the Chinese government encouraged rural people to leave their land in order to work in cities, which is also a well-known reason for the rapid urbanisation process in China (Li, 2005a, Huang et al., 2014). Meanwhile, to control such a large number of migrants rushing into urban areas at an appropriate level, China's unique household registration system (the *hukou* system) has been working all the time (Huang et al., 2014, Chen et al., 2011a). In the *hukou* system, the Chinese population are categorised into two groups: population living in rural areas with agricultural *hukou* status and population living in urban areas with non-agricultural *hukou* status. The differences between the two groups not only reflect the living area spatially, but also cover other social concerns including education and medical resources, pensions and other social welfare (Wang et al., 2017, Huang et al., 2014, Chen et al., 2011a). The stable net migrations presented in Figure 5.3 also imply that the *hukou* system with its initial purpose kept working to control Shenyang's migrations, which resulted in the gap between the total resident population and the total *hukou*-status population. Thus, urbanisation in China is not simply the spontaneous result of the actions of rural-urban migrations, but it is also politically influenced from the beginning (Wang et al., 2017, Li, 2005a).

Table 5.4 presents the number of total resident population and population with the *hukou* status, and the ratio of population with the *hukou* status to total population [37]. Overall, the ratio has declined since 2000, and it remains at a stable level of approximately 88 percent between 2010 and 2014. The total resident population increased from 7.20 million to 8.28 million with a 15 percent growth from 2000 to 2014, and the population with the *hukou* status increased from 6.85 million to 7.30 million with only 6 percent growth during the same time period. The gap between total resident population and population with the *hukou* status is defined as the number of population that live in the city but without the

[37] The information of total resident population of Shenyang has been recorded in Shenyang Statistical Yearbook since 2009. Also, in Shenyang Statistical Yearbook (2015), the information of total resident population in the year of 2000 and 2005 is listed. Thus, Table 5.4 lists the ratio of population with the *hukou* status to total resident population from 2009 to 2014, plus the information in 2000 and 2005.

hukou status, and most of such population is floating population (*liudong renkou*)[38]. According to the research of migration and the *hukou* system by Fan (2008), most floating population work hard and wish to have qualifications to receive the *hukou* status in the cities where they work, and the *hukou* system works to control the number of migration with the hukou status converted from floating population at a stable level. For the case of Shenyang, the growth of the population with the *hukou* status is lower than the growth of the total resident population, implying that the *hukou* system has been playing an important role on controlling the number of migrations. According to the research by Fan (2008), the increase of population with the *hukou* status from the migration concern reflects not only the *hukou* reform[39] but also the increased prominence of market forces in migration movements towards large cities.

Table 5.4 Total resident population, population with the *hukou* status, and ratio of population with the *hukou* status to total resident population

Year	Total resident population (million)	Population with the *hukou* status (million)	Ratio of population with the *hukou* status to total resident population
2000	7.20	6.85	95.10%
2005	7.44	6.98	93.89%
2009	7.98	7.19	90.10%
2010	8.10	7.19	88.77%
2011	8.18	7.22	88.35%
2012	8.22	7.24	88.09%
2013	8.25	7.27	88.06%
2014	8.28	7.30	88.19%

[38] The floating population (*liudong renkou*) is a unique concept in China that is tied to the *hukou* system. Individuals who do not live at their *hukou* locations are considered as floating population, and this concept is based on the notion that the *hukou* location is where one belongs and that migration is not considered official and permanent until the migrant's *hukou* location is changed. Regardless of when actual migration occurred, a person is viewed as part of the floating population as long as his or her usual place of residence is different from the *hukou* location.

[39] The *hukou* reform in China aims to ease economic and social inequality between floating population and population with the *hukou* status. In 1990s, the government gradually issued the *hukou* reform policies to allow rural residents to register with *hukou* status in small towns. The major changes at the city level began in early 2000s, which the *hukou* reform advanced in small and medium-sized cities. The intensity and scope of the reform increased and expanded after 2013. In 2014, *The National Urbanisation Plan (2014-2020)* emphasised urban hukou reform to ensure 100 million non-*hukou* migrants to have urban *hukou* status.

Source: Author's calculations based on *Shenyang Statistical Yearbook* (years vary)

Besides the impacts of the hukou system on the migration, motivations for migration also influence migrants' decision on changing their residential locations. As discussed in the background chapter, Shenyang is the largest city with the second-largest GDP in the northeast China, and this economic advantage attracts massive migrants into the city, resulting in the increased urbanisation. Apart from its economic motivations, other advantages such as social motivations also attract migrants to move into the city. The thesis will focus on education and medical resources as the two main social motivations that attract migrants to move into the city.

For educational resources, Shenyang has top-ranking high schools within Liaoning Province, such as Dongbei Yuchai High School and Liaoning Shiyan High School. Also, Northeastern University, a member of Project 985[40] and Project 211[41], is located in Shenyang. By 2014, Shenyang had 1,783 educational schools and institutions, including 79 higher educational institutions, 1,157 kindergartens, 507 primary and junior high schools, 87 senior high schools and 82 vocational schools. These comprehensive educational resources provide opportunities for migrants and their children to receive education; educational problems are a big concern for migrants in China (Zhou and Cheung, 2017).

The outstanding and comprehensive medical resources also attract migrants from outside to settle in the city. China Medical University, The First Hospital of China Medical University and Shengjing Hospital are located in Shenyang, and these three top-ranking hospitals provide high-level medical treatment for patients within the province (Shenyang Statistical Bureau, 2014). With regard to medical policies, the municipal government has published the relevant policies to proceed with reforms of the health care system, such as

[40] Project 985 is a project that was first announced by the former Chinese leader Jiang Zemin at the 100th anniversary of Peking University on 4th May, 1998. The project aimed to improve the Chinese higher education system to achieve world-class levels in the 21st century. The project involved both central and local governments allocating a massive amount of funding to certain universities, in order to help them to build and improve research facilities, hold international conferences, attract world-renowned faculties and visiting scholars, and help Chinese faculties to attend conferences abroad.

[41] Project 211 is a project for national key universities and colleges introduced by the Education Ministry in 1995. The project aimed to build 100 universities with high-level research standards to enter the 21st century in China. Compared to Project 985, Project 211 covers more higher education institutions over the country.

The Main Points of the Medical and Health System Reform for Shenyang (years vary). These policies are informed by the policies issued by central and provincial government, such as *Notice of the State Council on Issuing the Plan on Recent Priorities in Carrying out the Reform of Health Care System* by the central government in 2009, and *The Notice on Printing and Distributing the Implementation Opinions on the Implementation of Major Disease Insurance for Urban and Rural Residents* by the provincial government in 2014. The implementation of these medical policies reinforced the medical system in Shenyang. For example, through *The Main Points of the Medical and Health System Reform for Shenyang* in 2014, Shenyang introduced major disease insurance for both urban and rural residents, and the project compensated 4,551 residents with a total of 21.54 million yuan from January to August 2014 (Shenyang Statistical Bureau, 2014).

Those educational and medical resources are considered as social motivations that attract migrants to move and settle in the city, which indirectly boost Shenyang's urbanisation to a higher level. In order to enjoy those social welfare and to access urban benefits equally as the residents with the *hukou* status, the *hukou* system authorises the *hukou* status to those qualified floating population to ensure they have equalities to enjoy the social welfare. Meanwhile, the *hukou* reform lowers the threshold of the *hukou* qualification, which helps those people to receive the *hukou* status with few barriers in a short time. Thus, the *hukou* system with the reform plays an essential role in Shenyang's urbanisation and migration, meanwhile it also controls the migration at a stable level due to its initial purpose.

Besides the impacts of the *hukou* system and social motivations on the migration, migration types are also analysed for the case of Shenyang. Huang et al. (2014) also categorised three types of China's migration: intra-municipal (population from rural areas go to urban areas in the same city); inter-municipal (population from less-developed cities go to urban areas in more-developed cities); and inter-provincial (population from less-developed provinces go to urban areas in more-developed provinces). Figure 5.4 presents two sources of Shenyang's urban migration: migration-in from Liaoning Province and migration-in from other provinces. Shenyang has a 32,000 annual migration-in from Liaoning Province on average, which can explain its ranking in the top two developed cities in the province. It also has a 28,000 annual in-migration from other provinces on average, which reflects the fact that Shenyang has the capacity to attract population from other areas outside the province. From 2005, in-migration from Liaoning Province was

overtaken by the in-migration from other provinces. These quantitative characteristics reflect not only how the opening-up of the economy stimulated migration from less-developed areas to more-developed areas (Huang et al., 2014), but also the migration categories. The two main suggested reasons for this are surplus labour forces in some less-developed areas and widening income gaps between less-developed areas and more-developed areas (Gu et al., 1999).

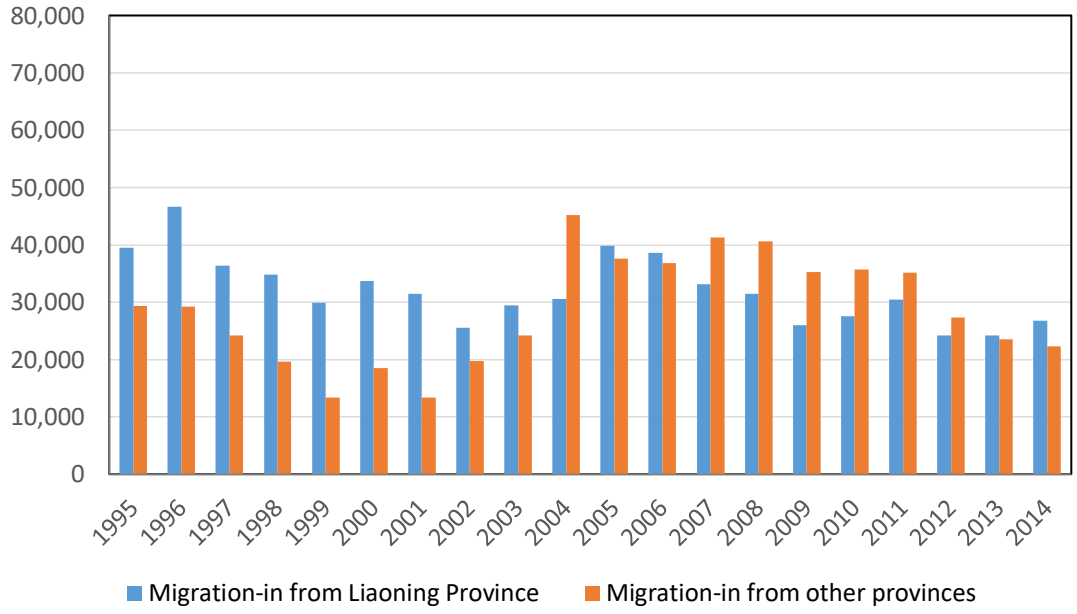


Figure 5.4 Shenyang's urban migration-in from Liaoning Province and other provinces 1995–2014

Source: *Shenyang Statistical Yearbook* (years vary)

5.4.2. Further discussions on housing investment

According to the regression models, the results demonstrate that housing investment can drive urbanisation and it has a positive relationship with urbanisation. The chapter thus discusses housing investment further.

The source of housing investment in China is categorised into three main sections by statistical departments: domestic investment (DI); investment from Hong Kong, Macao and Taiwan (HMTI); and foreign direct investment (FDI). Figure 5.5 presents the

quantitative and compared descriptions of DI, HTMI and FDI from 2002 to 2014[42]. From the histogram, it is clear that DI was the dominant investment source, as it accounted for over 50 percent of total housing investment annually. DI had an increasing trend with a 27 percent annual increase rate on average. The results not only illustrate how Shenyang's housing market was booming like other major Chinese cities after 2000 but they also provide support for the idea that housing is the primary driver of the urban economy for Chinese cities (Dreger and Zhang, 2013). However, DI in 2014 experienced a 10 percent drop compared to 2013, showing a 'recession' in the housing market. From the national housing market report, it can be seen that China's housing market had an adjustment in 2014, and housing investment as well as housing prices experienced an apparent decline (National Real Estate Information Centre, 2015). The main reasons for this recession included tightening mortgages from banks, changes in supply and demand, and downward expectations from the housing market. Moreover, because housing purchasing power had been overdrawn in the previous years, housing stocks started accumulating (National Real Estate Information Centre, 2015). Shenyang's housing market was in a similar situation because of the national housing market. Shenyang Statistical Bureau (2014) indicated that Shenyang's housing market entered into an adjustment period, and total housing investment dropped 9.5 percent compared to the year 2013. Also, the taxation of real estate was 16.25 billion yuan in 2014, a drop of 20.6 percent compared to the year 2013, and the total floor area of housing sold was 14.5 million m^2 in 2014, a drop of 17.2 percent compared to the year 2013. Those figure reductions reflect a market shrinkage in Shenyang. In order to activate the market and boost purchasing power, the municipal government issued *The Notice of Releasing the Purchase Restriction of Housing* in September 2014.

HTMI and FDI, also critical investment sources, have increasing trends over time, but FDI started to decline after 2013. Smarzynska Javorcik (2004) indicated that FDI was given much attention by policy makers, as it could bring in a great deal of capital and new technologies for economic development. Plus, FDI can help to increase productivity and bring competitiveness to domestic industry (Smarzynska Javorcik, 2004). Meanwhile, it also assists urban growth by employing formerly rural workers and by shifting the sectoral structure towards industry and services (Lin, 2001). Song and Gao (2007) also indicated

[42] In the Shenyang Statistical Yearbook, housing investment is categorised from the year 2002. Thus, the classification analysis is for the period between 2002 and 2014 for this research.

that increasing housing prices attracted FDI into China's market in the short term. Thus, according to the increasing GDP and the increasing housing prices in Shenyang, FDI works to boost the urban economy and housing market. The decline that started in 2013 implies that foreign investors were also considering the housing bubbles in Chinese cities (Dreger and Zhang, 2013), and were cautious about further housing investment.

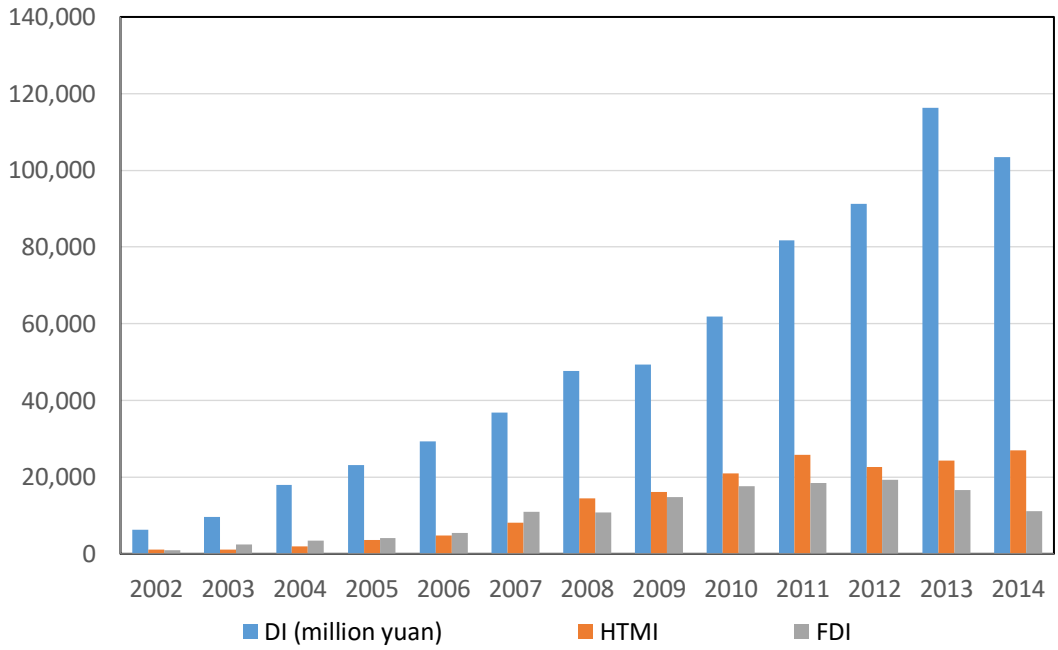


Figure 5.5 DI, HTMI and FCI of Shenyang 2002–2014

Source: *Shenyang Statistical Yearbook* (years vary)

In domestic investment, the investment of state-owned enterprises (SEI), the investment of private companies (PI) and the investment of shareholding companies (SI) are the three main sections. State-owned enterprises (SOEs) as the main body of SEI and SI[43] played an important role and formed the core of the Chinese urban economy[44] in its history (Wang et al., 2005, Zhang and Rasiah, 2014). Figure 5.6 presents the quantitative relationships between SEI, PI and SI. Compared to PI, SEI and SI occupy over 50 percent

[43] Wang et al. (2005) mentioned that many SOEs had been transformed into shareholding companies during the SOE reforms.

[44] According to Wang et al. (2005), most SOEs were established after 1949 and relied on older generations of technologies and machinery. Many SOEs were operating a deficit and relied on bank loans and government support. In the 1990s, the government carried out an industrial restructuring programme in order to increase the SOEs' efficiency, including staff reductions, privatisation, merging, closure and bankruptcy.

of the three investment sources. SEI accounts for a very small portion of the three investment types in this period. The fundamental reasons for this are: the institutional reforms of SOEs, which transformed many SOEs into shareholding companies; and the fact that many of these shareholding companies shifted their role from housing allocators in a centrally planned economy to housing investors in a more dynamic housing market (Zhang and Rasiah, 2014, Wang et al., 2005). Zhang and Rasiah (2014) indicated that the huge profits generated from housing sales encouraged many SOEs to run housing businesses. Between 2002 and 2014, the SEI in Shenyang increased approximately ten times from 362 million up to 3,388 million annually, which can explain SOEs' new role in the housing market. However, despite the positive development of SOEs, their role conversion led to some harmful practices for the economy (Zhang and Rasiah, 2014). As housing has a commercial value, it allowed SOEs to speculate in the housing market. Due to the reforms of SOEs, government controls on them were reduced, giving them greater chances to divert a large amount of capital to unnecessary activities[45]. Moreover, SOEs have an advantage over private companies with regard to applications for land use rights, as they can use their interrelationship with local governments (Zhang and Rasiah, 2014). This can explain the over-half ratio of SEI and SI for Shenyang.

[45] Unnecessary activities in this context of Chinese housing development refer to a series of activities for SOEs and shareholding companies converted from the previous SOEs: SOEs and shareholding companies are able to invest more capital on land acquisition for further housing constructions, and after acquiring land they usually hold the land to wait housing price to increases. Then they will develop the land for housing to receive profits as maximum as possible.

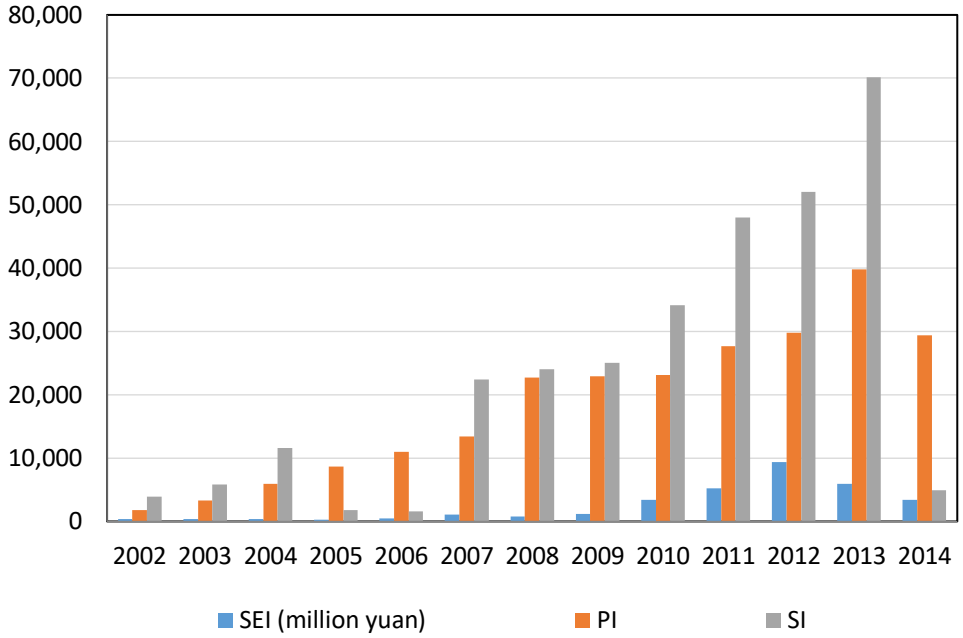


Figure 5.6 SI, PI, and SEI of Shenyang 2002–2014

Source: *Shenyang Statistical Yearbook* (years vary)

5.5. Chapter summary

This chapter discusses the model results and explains the migration and housing investment for Shenyang's case. According to the results, GDP per capita is significant to urbanisation at the 1 percent level in all the models. The results also confirm that housing investment can drive urbanisation for Shenyang's case.

Apart from the model discussion, the chapter also explains how migration might be another key factor influencing Shenyang's urbanisation. From the analysis, it can be seen that the stable annual net migrations of Shenyang imply that the *hukou* system works by controlling Shenyang's migrations at an appropriate level, which demonstrates that urbanisation is not only a spontaneous action of rural-urban migrations but is also shaped by political behaviour. The quantitative characteristics of the two sources of in-migration for Shenyang explain Shenyang's economic role in the province and also imply that Shenyang has a greater ability to attract population from areas outside the province, compared to the other cities within Liaoning Province.

This chapter also provides a further discussion on Shenyang's housing investment. It discusses three types of housing investment and shows that DI is dominant in Shenyang. A 27 percent annual increase in the rate of DI implies that Shenyang's housing market

has been developing quickly, like other major Chinese cities after 2000. A 10 percent decline implies that the housing market experienced a 'recession' after 2013. The main reasons for this were tightening mortgage applications/acceptance from banks, changes in supply and demand, and downward expectations from the housing market. Housing purchasing power was overdrawn in the previous years, and housing stocks started accumulating. Through the analysis, we see that FDI was working on Shenyang's urban economy and contributed to the housing market. Compared to DI, an earlier decline in FDI in housing implies that foreign investors considered the housing bubble and were cautious about further housing investment. Also, the examination of SEI and SI in Shenyang's housing demonstrates SOEs' important role in housing development and explains SOEs' institutional conversion in the housing market.

This chapter examines the connection between urbanisation and housing for Shenyang through housing investment and other economic factors. As rapid urbanisation results in massive population movement into cities, housing demand increases correspondingly (Malpass, 1986). The next chapter will present the analysis of Shenyang's housing demand.

6. Results and analysis of housing demand in Shenyang

6.1. Chapter introduction

This chapter explains the research results for housing demand and the corresponding housing issues. In order to achieve **RO3** of identifying the main drivers that influence housing demand, the chapter presents and discusses the housing demand model results for Shenyang's case. In order to achieve **RO4** of explaining how these factors influence housing demand, the chapter discusses each factor and its corresponding problems, including income, housing prices, demographic factors, and commuting and residential expenditures.

6.2. Model results

First of all, the thesis lists a descriptive statistic for each variable in the models (Table 6.1). In order to reduce heteroscedasticity, all variables are taken as logarithms in the regression model. Table 6.2 presents a summary of all the model results.

Table 6.1 Descriptive statistics of the housing demand models

	Minimum	**Minimum**	**Mean**	**Std. Deviation**
S	2.750	3.456	3.129	0.260
I	6.750	8.490	7.596	0.588
P	5.810	6.870	6.425	0.302
C	3.680	6.430	5.093	0.958
HS	1.020	1.190	1.104	0.056
RE	3.900	5.920	4.957	0.657

Table 6.2 Results summary of the housing demand models

Variables	**Step (1)**	**Step (2)**	**Step (3)**	**Step (4)**
I	0.449***	0.126	0.430***	0.073
	(0.048)	(0.095)	(0.147)	(0.179)
P	-0.021	-0.105	-0.076	-0.049
	(0.094)	(0.076)	(0.115)	(0.096)
C	-	-	-0.041	-0.012
			(0.116)	(0.089)
HS	-	-	0.913	1.006
			(1.725)	(1.346)
RE	-	-	0.114	0.116
			(0.085)	(0.069)
S(-1)	-	0.810***	-	0.874***
		(0.220)		(0.236)
Constant	-0.147	0.338	-1.990	0.666
	(0.277)	(0.253)	(2.718)	(2.186)
Adjusted R^2	0.979	0.987	0.979	0.988

Note: standard errors in parentheses. ***indicates significant at 1% level; **indicates significant at 5% level; *indicates significant at 10% level.

6.3. Results discussion

In Step (1), the model estimates the empirical housing demand equation between housing space per capita (S), income (I) and housing prices (P) using time series for the case of Shenyang, assuming that the housing market is in equilibrium all the time. The results show that the adjusted R^2 is 0.979, which provides a tighter fit for the data and fewer errors. For the coefficients, income (I) is statistically significant at 1 percent level and positively related to housing space per capita (S), suggesting that income had a positive effect on and significantly influenced the housing demand during the research period. The results also show that housing prices (P) have a negative but not significant relationship with housing demand. The results show that the estimate of income elasticity is 0.449 with a standard error of 0.048 and the estimate of price elasticity is 0.021 with a standard error of 0.094.

In Step (2), the model estimates the housing demand, assuming that the housing market is not in equilibrium, adding a partial stock adjustment (S_{t-1}). The results show that the adjusted R^2 is 0.987, which is higher than the situation in Step (1). Adding a partial stock adjustment, only (S_{t-1}) is statistically significant at 1 percent level. Income and price are still positively and negatively correlated with housing demand, respectively. From the results, we can derive from Equation (4.21) the partial adjustment coefficient τ = (1-0.810) = 0.190. Dividing the coefficients of income and price in Equation (4.22) by τ, we obtain estimates of the income and price elasticities for the housing stocks, which are 0.663 and -0.552 respectively. The magnitudes of the income and price elasticities are larger than the estimates from Step (1) because they allow for the effects of income and price to work out through time.

In Step (3), the model estimates the housing demand based on Step (1), adding commuting costs, residential expenditure and demographic factors. The results show that the adjusted R^2 is 0.979, which provides a tight fit for the data and fewer errors. For the coefficients, income (I) is statistically significant at 1 percent level and positive, suggesting that income has a positive effect on and significantly affects housing demand. The housing prices (P) have a negative relationship with housing demand but are not statistically significant. The coefficient of household size (HS) is positive, suggesting that housing demand will expand when the number of household increases. The coefficient of commuting expenditure (C) shows that commuting expenditure has a negative relationship with housing space per capita. The coefficient of residential expenditure (RE) is positive to housing space per capita. The results show that the estimate of income elasticity is 0.430 with a standard error of 0.147 and the estimate of price elasticity is -0.076 with a standard error of 0.115.

In Step (4), the model assumes that the housing market is not in equilibrium, adding a partial stock adjustment (S_{t-1}) based on Step (3), in order to estimate the housing demand involving the factors of economics, demographics, commuting costs and residential expenditure. The results show that the adjusted R^2 is 0.988, higher than in Step (3), suggesting that it also explains well the housing demand for Shenyang's case. Adding a partial stock adjustment, only (S_{t-1}) is statistically significant at 1 percent level. For the coefficients, income (I) and housing prices (P) are positive and negative respectively, and not statistically significant to housing demand. The coefficients of household size (HS) decrease compared to Step (3), being 1.006 with a standard error of 1.346.

Compared to Step (3), the coefficient magnitudes of commuting expenditure (C) and residential expenditure (RE) retain their relationships with housing demand. From the results, the partial adjustment coefficient τ = (1-0.874) = 0.126 deriving from Equation (4.21). Dividing the coefficients of income and price in Equation (4.23) by τ, we obtain estimates of the income and price elasticities for the housing stocks, which are 0.579 and -0.388 respectively.

Overall, according to the adjusted R^2 of the models (Table 6.3), four housing demand equations explain Shenyang's housing demand well. Adjusted R^2 in the models with partial stock adjustment (Step (2) and Step (4)) is higher than those in the models without partial stock adjustment (Step (1) and Step (3)). This implies that the models with partial stock adjustment can explain more of the sample variation of the housing stock. Involving demographic factors and commuting and residential expenditure also gives a higher adjusted R^2, which implies that these factors can help to explain housing demand.

Furthermore, the lagged models consider disequilibrium of the housing stocks that the housing market is not as liquid as other asset markets and hence cannot quickly re-equilibrate in response to a supply or demand shock. The main reason for the disequilibrium is that heterogeneous characteristics and information asymmetries make matching buyers and sellers more difficult, and buyers are not likely to respond quickly as houses are the most expensive purchase made by households (Zabel, 2016). Besides heterogeneous characteristics and information asymmetries, the disequilibrium may also result from shifts in supply and demand conditions (Jones et al., 2016). For shifts in supply conditions, it include changes in construction wages, building material costs, short-term lending rates. For shifts in demand conditions, it include changes in borrower income or wealth, changes in market demographics and changes in the price of rental properties. As market demographics are strongly linked to growth of urban population, this research has considered population growth and mitigated its impact on the demand models by dividing population for housing stocks.

Table 6.3 Adjusted R^2, income elasticity and price elasticity for the housing demand models

	Adjusted R^2	Income elasticity	Price elasticity
Step (1)	0.979	0.449	-0.021
Step (2)	0.987	0.663	-0.552
Step (3)	0.979	0.430	-0.076
Step (4)	0.988	0.579	-0.388

6.4. Further discussions on each factor

6.4.1. Income

In the housing literature, income elasticity reflects how income affects housing demand, which refers to the ratio of the magnitude of housing demand changes to the magnitude of income changes (Mulford, 1979). Chow and Niu (2010) used time series from 1987 to 2006 to study housing demand for China's housing market and they obtained a range of income elasticities of housing demand: between 0.764 and 0.833. The results imply the housing demand in China tends to be inelastic, which means that housing is more of a basic life necessity for Chinese residents currently. Zheng and Liu (2005) also studied Beijing's housing demand and obtained an income elasticity of housing demand of around 0.86. The results indicate that housing in Beijing tends to be a necessity rather than an investment good. Chen and Jin (2014) attempted to estimate the income elasticity of housing demand in Shanghai based on a household survey conducted by the National Bureau of Statistics of China in 2007, and the finding indicated that the income elasticity of housing demand in Shanghai was between 0.375 and 0.447.

In this study, the range of income elasticities of housing demand is between 0.430 and 0.663, and the results are similar to the outcomes of Chow and Niu (2010) at the aggregate level in China, those of Zheng and Liu (2005) for Beijing's housing market and those of Chen and Jin (2014) for Shanghai's housing market. The results show that the income elasticity is inelastic, implying that housing is currently a *necessity* rather than an *investment* good for Shenyang's residents. Furthermore, income is positively related to the housing space per capita, which exhibits a similar situation to that in most Chinese cities (Hui, 2004).

In order to explain further how income affects housing demand, the thesis will examine the relationship between income and housing expenditure. Figure 6.1 and Figure 6.2 demonstrate the relationship between income and housing expenditure per person from 1997 to 2014[46]. From 1997 to 1999, nationwide housing reform was still proceeding, and welfare housing provision had just been abolished. In this period, people's notion of housing was still closely related to the old welfare housing provision. Fewer people were willing to spend money on house purchases, resulting in no more than 10 percent of income being spent on housing purchases annually. Another reason for this low ratio is the funding shortages for residential house construction. In the market, few options of newly constructed housing communities were provided to consumers, resulting in less investment in house purchasing by families. In the new century, with the newly established HPF system, residential housing purchasing was much easier in Shenyang. Within the rapid development of real estate, the housing market in Shenyang arrived at its prosperous peak. Within the disposable income bracket, housing consumption in Shenyang became popular, especially after 2004. Housing expenditure gradually increased its proportion of people's annual income between 2000 and 2012, especially after 2003, which implies that people were willing to spend more on house purchasing after this date.

Zhong (2009) indicates that during this period, the increase in housing expenditure capacity in some Chinese families was faster than the income growth rate. Zhong also provides the example of some Chinese households in the cities with 3,000 yuan monthly income that possibly had approximately 600 yuan to spare for housing expenditure. When the income of these households rose to 4,000 yuan monthly (a 33 percent increase), the housing expenditure rose to approximately 1,200 yuan (a 100 percent increase). Zhong indicates that the income increases influenced housing expenditure significantly for these households, as housing expenditure is highly sensitive to income. For Shenyang, the ratio of housing expenditure to income increased by between 10 percent and 70 percent during this period, which means that housing was considered to be a necessity. On the other hand, the high increase also provides evidence for the fact that Shenyang's housing development moved quickly and housing demand in the market showed strong growth. After 2012, Shenyang's housing market entered a steady period, and house purchasing

[46] The data on housing expenditure are available from 1997 in the *Shenyang Statistic Yearbook*.

became a rational consumption for most families[47]. Compared to the previous higher ratio of housing expenditure to income, the figure started to decline after 2012. This ratio decline can explain the decrease in housing sales and the increase in the number of houses for sale between 2012 and 2014 (Figure 6.3), and it also gives an evidence of the housing supply over the demand. The housing supply over the demand has resulted the housing stock hoarding.

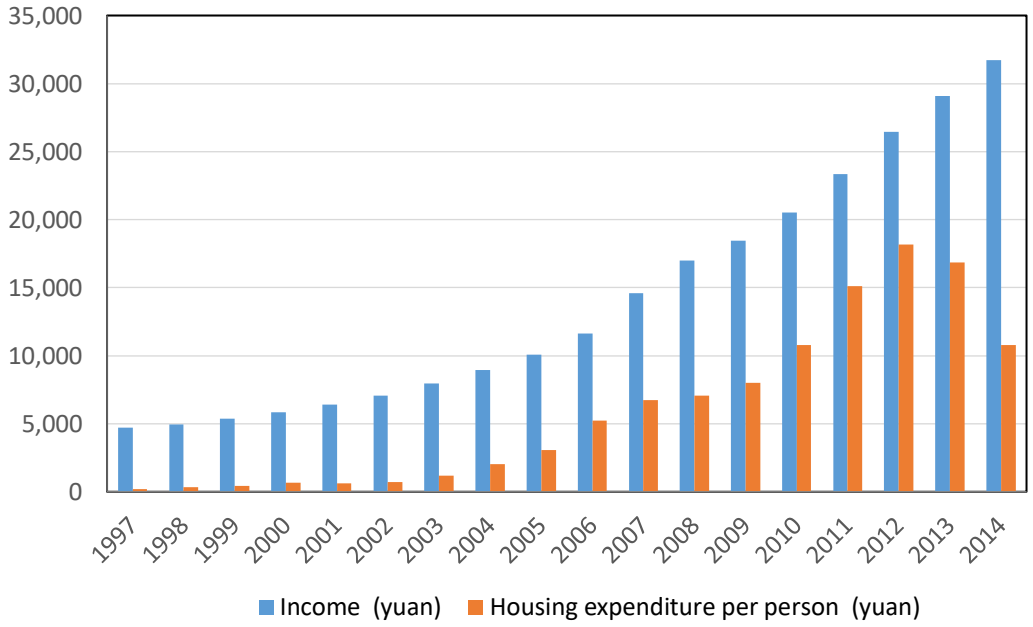


Figure 6.1 Income and housing expenditure per person of Shenyang 1997–2014

Source: Author's calculations based on *Shenyang Statistical Yearbook* (years vary)

[47] Rational consumptions on housing in Shenyang mean that people do not blindly follow for housing purchasing without considerations on what they actually need for housing, such as housing sizes and locations. Furthermore, such rational consumptions also mitigate excessive growth of housing prices due to declines of housing transactions.

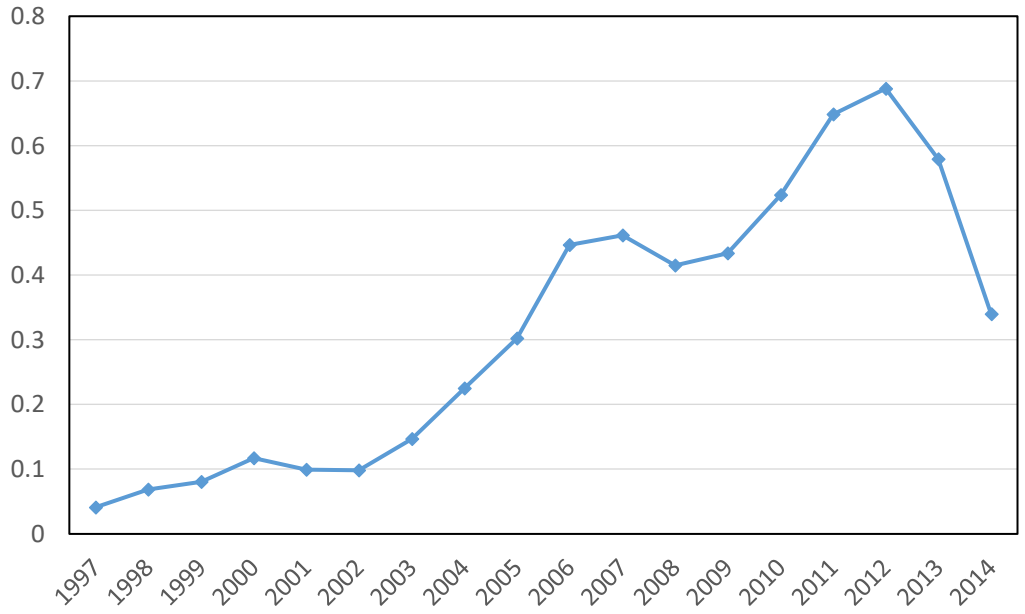


Figure 6.2 Ratio of housing expenditure per person to income of Shenyang 1997– 2014

Source: Author's calculations based on *Shenyang Statistical Yearbook* (years vary)

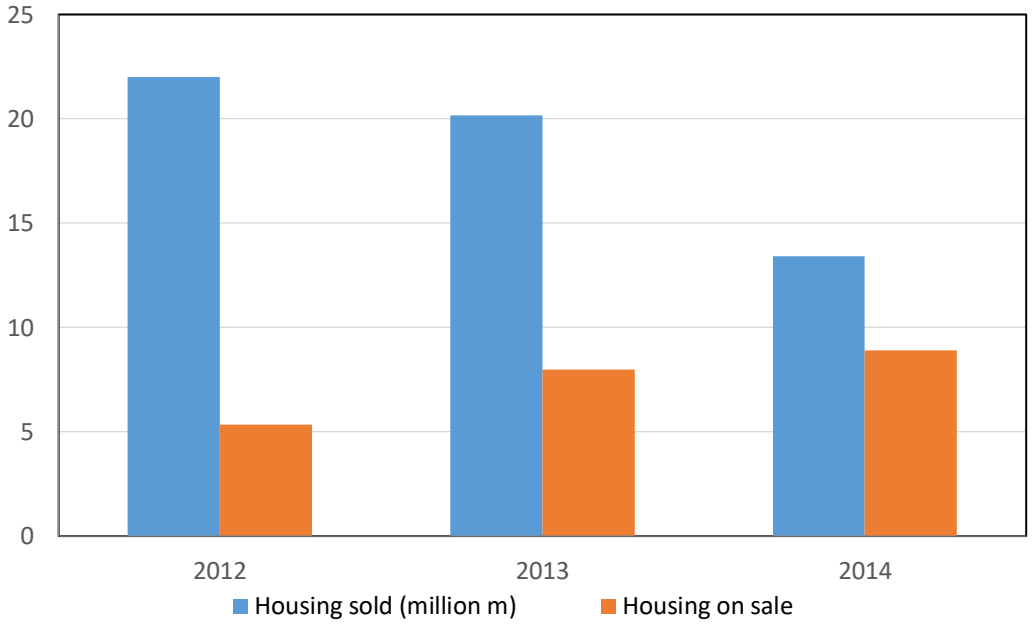


Figure 6.3 Floor area of housing sold and houses for sale 2012–2014

Source: *Shenyang Statistical Yearbook* (years vary)

6.4.2. Housing prices

The price elasticity of housing demand reflects how housing prices affect housing demand, which refers to the ratio of the magnitude of housing demand changes to the magnitude of price changes (Zhong, 2009). In the study of Chow and Niu (2010), the price elasticity of housing demand at the nationwide level is between -0.333 and -0.425. Yang et al. (2015) estimated the housing demand for six provinces in China and obtained a price elasticity for Liaoning Province of -0.162. These results show that the levels of price elasticity of housing demand are relatively low, compared to the US levels, which are between -0.35 and -0.4 (Yang et al., 2015). Yang et al. (2015) also indicate that the housing demand in some Chinese areas cannot be suppressed by raising housing prices, which means that changes in housing prices do not significantly influence housing demand in these areas.

In this study, the price elasticity of housing demand is between -0.021 and -0.552, which is similar to the outcomes of Chow and Niu (2010) and Yang et al. (2015). The results show that the price elasticity is inelastic, which means that the changes in housing prices do not have much influence on Shenyang's housing demand.

Figure 6.4 demonstrates twenty years' housing prices and the floor area of housing sold in Shenyang. Overall, both transaction volume and housing prices increased rapidly from 1995 to 2011. The drop of housing prices in 1997 can be explained by the fact that the housing market was affected by the housing reform. Due to the entire abolishment of welfare housing provision in 1998, consumers were cautious about house purchases and could not forecast the coming trends in the housing market. The official ending of the welfare housing provision provided an institutional impetus for a rapid increase in not only housing transactions but also housing prices (Chen et al., 2011b). This viewpoint can explain how Shenyang's housing prices and transaction volume have increased gradually since the housing reform. After 2012, house prices become stable and the transaction volume has declined sharply, it gives an implication of the housing supply over the demand. The over-housing supply helped to mitigate the housing affordability indirectly, as the over-housing supply with less demand made the housing prices to remain stable. However, the over-housing supply has resulted in the housing stock hoarding, which made the city more compact unnecessarily with higher building densities. The housing stock hoarding will result in housing vacancy, and it will be discussed in Chapter 7.

From the demand side, a possible explanatory factor for the rapid increase in housing prices is the massive housing demand from Shenyang's residents. Shaw (1997) indicated that in the Chinese social environment, since housing is an essential requirement for each family, the demand for housing is usually inelastic. He also indicated that the rapid expansion of the urban population was key to the high demand for housing. In the previous chapter it shows that Shenyang experienced an increasing urbanisation rate during the research period, and it was concluded that migration is a possible explanatory factor for this increasing urbanisation trend. Chen et al. (2011b) indicated that rapid urbanisation and massive migration, with the transfer of household registration, led to urban housing growth and increased the demand for urban housing. As some migrants do not have urban household registration (the *hukou* status), they are not eligible for state-sponsored affordable housing, the price of which is much lower than commercial housing. Instead, they may purchase commercial housing through the urban housing market, which leads to an increase in housing prices (Chen et al., 2011b). Figure 5.3 demonstrates that the annual net migration of Shenyang between 1995 and 2014 ranged between 20,000 and 45,000. Based on the viewpoints of Shaw (1997) and Chen et al. (2011b), this stable annul net migration can explain the increasing housing demand and housing prices.

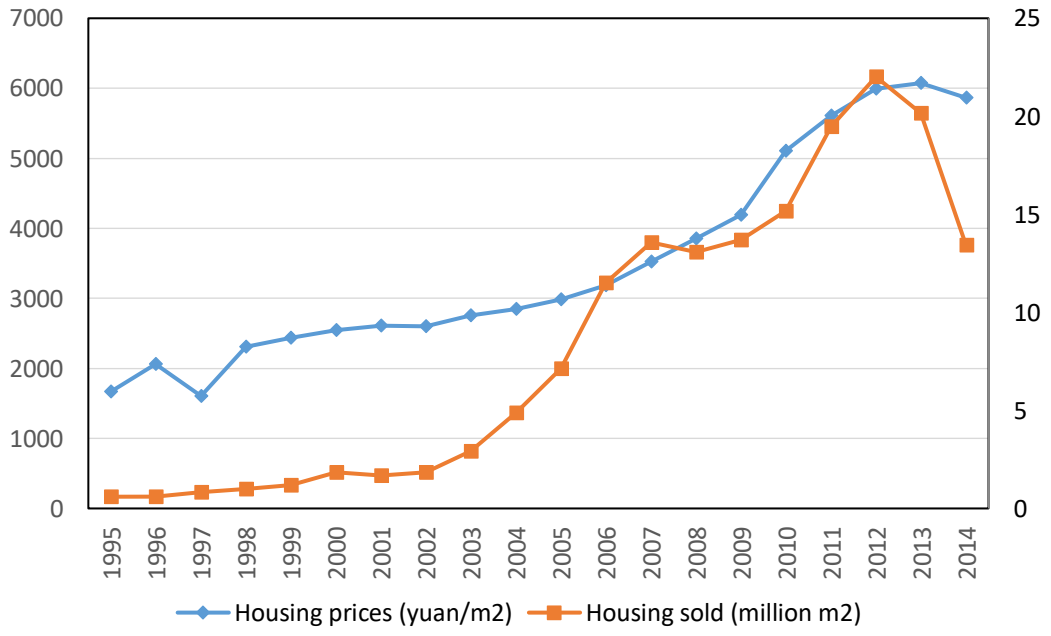


Figure 6.4 Housing prices and floor area of housing sold of Shenyang 1995–2014

Source: Author's calculations based on *Shenyang Statistical Yearbook* (years vary)

6.4.3. Demographic factors

The regression results show that the average household size, a demographic factor, is not statistically significant to the housing demand for the case of Shenyang. This means that the household size is not the key factor that influences the housing demand in a statistical sense. The annual average household size declines with an increase in housing demand (Figure 6.5), supporting the ideas that average household size is negatively related to housing space per person (Mesthrige Jayantha and Lau, 2008). Mesthrige Jayantha and Lau (2008) also indicated that sometimes housing space per capita captures the demand factors that are not reflected in price changes because of the stickiness in housing prices. Usually, the price elasticity of demand is relatively low in these situations. Therefore, the level of sufficient demand is expected to change in response to other factors such as household size. Thus, changes in the household's preferences about the family size can have an impact on housing demand.

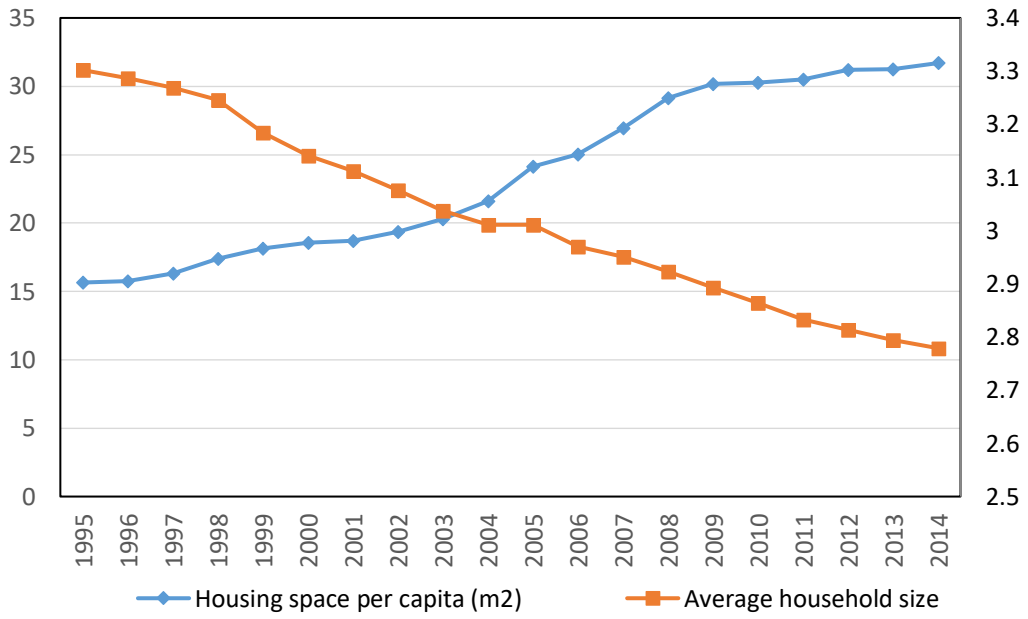


Figure 6.5 Housing space per capita and average household size of Shenyang 1995–2014

Source: Author's calculations based on *Shenyang Statistical Yearbook* (years vary)

Besides household size, other demographic factors may also have substantial impacts on housing demand. Gender differences in housing demand may denote differences in tenure history, wealth, income level and variation, expectations for marriage, concerns for maintenance and safety, *etc*. (Skaburskis, 1997). The value of the safety offered by

housing and freedom from maintenance may differ between men and women. Hayden (1982) also indicated that the demand for single-family suburban housing might differ between men and women, as a male-dominated family formation might disappear. Carliner (1973) and Mayo (1981) pointed out that female heads of household spent more on housing than male heads of household did. Limmer (1978) researched the female heads of households in the US with regard to how well they were housed, and indicated that women householders were more urbanised than the general population and they spent more on their houses, such as alterations and maintenance. In China, marriage and gender balance have also been reported to have an impact on China's housing demand (Li, 2005b, Xu et al., 2012). Zhang (2014a) indicates that usually both males and females generate the demand for housing; however, in China, if the gender difference is not balanced, especially the sex ratio at marriageable age, this will result in the situation where the female side puts forward a requirement that the male side must have housing for marriage. Eventually, this will stimulate a large number of single men to purchase housing, increasing housing demand. Wei and Zhang (2011) demonstrated that an imbalanced sex ratio causes increasing competition in the marriage market, where households with a son raise their saving rates in the hope of improving their son's odds of finding a wife. This increasing competition also causes increasing housing prices and higher housing demand in current China (Zhang, 2014a).

Figure 6.6 presents the number of marriages a year and the female ratio of the population of Shenyang during the research period. Overall, the number of new marriages saw an increasing trend with a range between 40,000 and 75,000. According to Zhang (2014a), this increasing figure generates more housing demand, as newly built households need either new housing to separate from their parents or more housing space for children. Also, the female ratio is balanced between 0.49 and 0.50 with a slightly increasing trend during the research period. According to Wei and Zhang (2011), this increasing trend can help to control an excessive increase in housing prices and an excessive requirement for housing sizes indirectly, as the competition between households with sons in the marriage market tends to be mitigated.

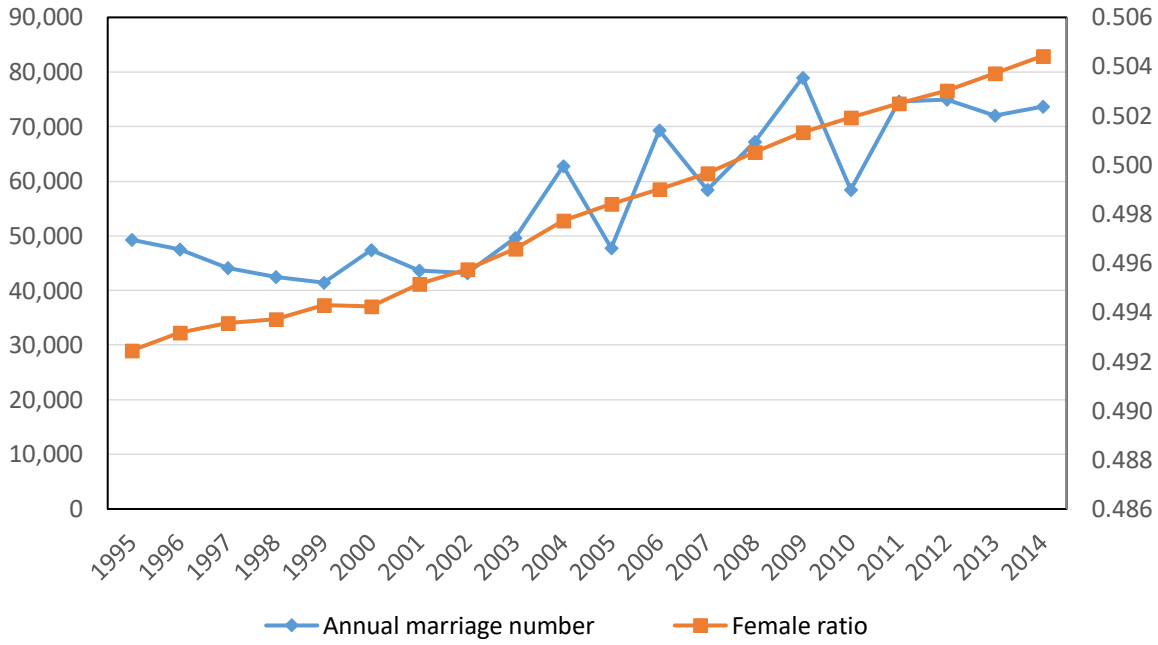


Figure 6.6 Annual number of marriages and female ratio of the population in Shenyang 1995–2014

Source: Author's calculations based on *Shenyang Statistical Yearbook* (years vary)

6.4.4. Commuting costs and residential expenditures

The model results show that commuting costs are negatively related to housing demand, and this proves the relationship in Alonso's equation (4.16) (**Section 4.3.2.3**). Even though commuting costs are not statistically significant to housing demand for the case of Shenyang, they do have an impact on housing in some ways. Figure 6.7 presents the ratios of commuting costs to income. Overall, the ratios show an increasing trend during the research period, which means that the residents spent more on commuting and transportation within the capacity of their disposable income. If it is assumed that commuting ways do not change and that fuel prices are stable during the period, the ratio implies that housing decisions show a preference for living far away from the city centre.

Alonso (1964) discussed the influences of residential location on travel distance and costs. From the demand side, if the land is more income elastic than travel costs, then people with a higher income will live farther away from the city centre; if the land is more travel cost elastic than income, this implies that rich people will live closer to the city centre. The results from the case of Shenyang show that the magnitude of income elasticity is much higher than commuting costs. Therefore, it can be concluded that the housing preference of people with a higher income is to live farther away from the city centre.

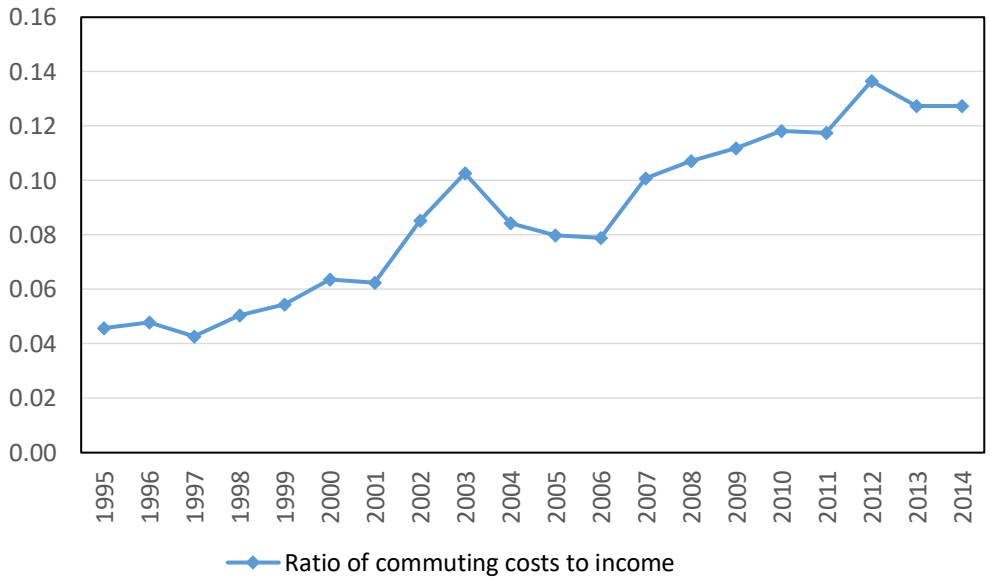


Figure 6.7 Ratios of commuting costs to income of Shenyang 1995-2014

Source: Author's calculations based on *Shenyang Statistical Yearbook* (years vary)

As mentioned in **Section 4.3.2.4**, the residential expenditures in this research cover rents and energy expenses. In detail, this includes expenditures related to residence, such as housing rents, expenditure on water and electricity, and fees of property management. However, as the data are an annual average for all the residents of Shenyang, they cannot reflect the actual situations for all types of residents. For example, people who either do not rent housing or live in the residential community without property management do not pay anything on rents or property management. Such reasons might cause insignificant coefficients in the models.

Figure 6.8 presents the ratios of residential expenditures to income for Shenyang during the research period. The ratio ranges between 0.05 and 0.10, and the average ratio is 0.07. Wu and Yang (2008) studied nationwide residential expenditures in China between 1978 and 2006, and the ratio of residential expenditures to income was maintained between

0.03 and 0.10. Focusing on the same research period between 1995 and 2006, the nationwide ratio was 0.08 on average. This comparison tells us that the level of residential expenditures of Shenyang's residents is approximately equal to the nationwide level. From Figure 6.8, the ratio can be divided into four main periods: a first increase period between 1995 and 1998; a second increase period between 1999 and 2003; a steady period between 2004 and 2008, and a decline period after 2008. Wu and Yang (2008) explained the periodical differences with the fact that the housing market-oriented factors enhanced the price level of residential consumption of residents living in cities and towns but did not affect actual residential consumption too much.

Furthermore, the periodical differences also reflect different stages of the housing development in Shenyang. During the first increase period between 1995 and 1998, housing was still a welfare resource, and people were able to increase their residential expenditure without experiencing housing financial difficulties. The second increase period between 1999 and 2003 started at a low level due to the abolishment of welfare housing distribution, and with the HPF system establishment and improvement, people had less housing financial pressure and were willing to spend more on their residence. These two increasing periods also indirectly reflect the fact that the housing market has developed; for example, improvements in property management enhance living standards, so people spend more money on property. The period between 2004 and 2008 shows that housing development entered a steady stage. After 2008, as the housing market had entered a steady period, house purchasing and related housing consumptions became rational for most families, and people spent money on other types of consumption. Correspondingly, the level of residential expenditures shows an overall declining trend.

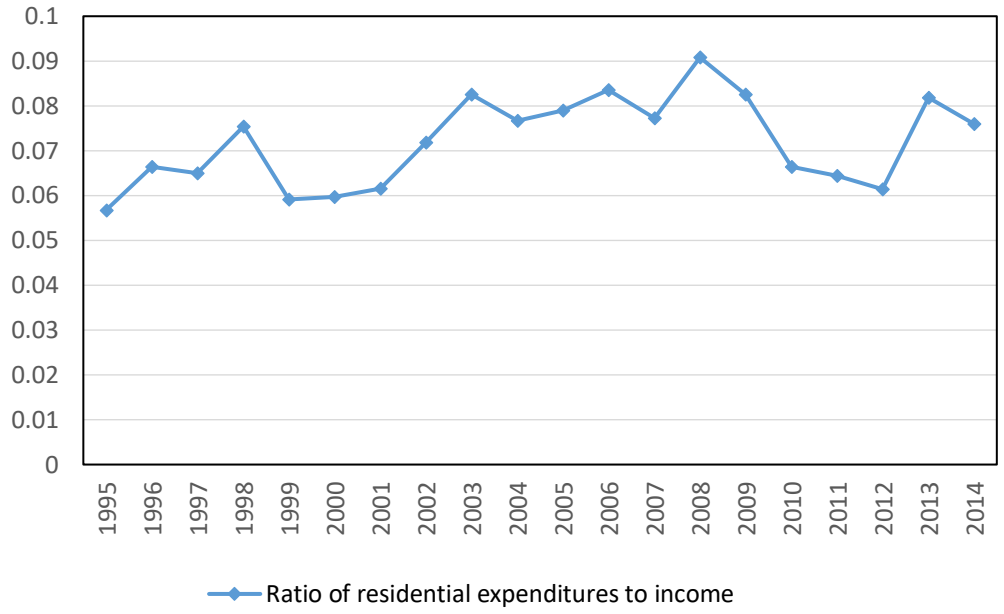


Figure 6.8 Ratios of residential expenditures to income in Shenyang 1995–2014

Source: Author's calculations based on *Shenyang Statistical Yearbook* (years vary)

6.5. Further discussions on housing affordability

Besides the housing demand factor discussions, housing affordability is an inevitable topic to discuss. As the market-oriented housing reform has been implemented in China since 1990s, people were encouraged to purchase houses in the market as free housing allocation system has been abolished. After the housing reform, the supply and demand of housing have become more market-oriented. The housing prices have been rising fast due to the fact that housing demand is greater than the housing supply at the beginning of the reform. As the housing prices keep soaring, low- and middle-income people find it difficult to afford housing. Taltavull et al. (2012) suggests two typical approaches to indicate the owner's housing affordability. One is housing price-to-income ratio[48], the other is housing expenditure-to-household income ratio. The housing price-to-income ratio aims to measure whether people can buy the housing, and the housing expenditure-to-household income ratio attempts to measure whether people can afford the payment after housing purchase (Taltavull et al., 2012). This section will discuss the housing affordability for the case of Shenyang in terms of these two indicators.

For the city of Shenyang, according to the research of the price to income ratio in 35 Chinese cities, the housing price-to-income ratio of Shenyang declined from 9.3 in 2001 to 6.4 in 2014 (Cao, 2015), and it is the only one in the 35 Chinese cities that the housing price-to-income ratio was in steady decline from 2001 to 2014. This shows that the growth of housing price was slower than the growth of household disposable income, and it implies that the housing affordability has been improved in Shenyang. Compared to the ratios of the other large cities, such as Beijing from 10.0 in 2001 to 14.5 in 2014 (Figure 6.9), Shanghai from 6.5 in 2001 to 11.9 in 2014 (Figure 6.10) and Guangzhou from 6.2 in 2001 to 11.8 in 2014 (Figure 6.11), the Shenyang's ratio is lower than the other large cities', implying that there is less housing affordability issues in Shenyang. The improved affordability on housing also reflects a success of the affordable housing programme with the policy implementation of *The Scheme of Affordable Housing Programme Implementation for Shenyang*, which gradually solved the housing affordability issue for the middle- and low-income people. On the other side, it also implies that the housing market in Shenyang is more sluggish than the other large Chinese cities. Meanwhile, the

[48] The price to income ratio is the nominal total housing price divided by the nominal disposable income per household. In the Chinese context, the total housing price is the average housing price per square meter multiplies the average housing space per household.

Shenyang's ratio of 6.4 in 2014 is lower than the ratio of 7.1 at the national level in the same year, implying that there was less housing bubble issue in Shenyang rather than the other large Chinese cities (Cao, 2015) (Table 6.4). This can also support the conclusion that housing is still a necessity for the most residents of Shenyang in terms of the inelastic income elasticity.

Figure 6.9 Housing price-to-income ratio in Beijing from 2001 to 2014

Source: Cao, 2015

Figure 6.10 Housing price-to-income ratio in Shanghai from 2001 to 2014

Source: Cao, 2015

Figure 6.11 Housing price-to-income ratio in Guangzhou from 2001 to 2014

Source: Cao, 2015

Table 6.4 Housing price-to-income ratio for some large Chinese cities in 2014

Beijing	14.5	Hangzhou	10.8
Shanghai	11.9	Nanjing	8.9
Guangzhou	11.8	Wuhan	7.7
Shenzhen	20.2	Chengdu	6.9
Tianjin	9.6	Chongqing	7.0
Xiamen	15.5	Kunming	6.7
Xian	5.8	Changsha	5.1
Shenyang	6.4	The national average	7.1

Source: Cao, 2015

Besides housing price-to-income ratio, housing expenditure-to-household income ratio is another indicator to access housing affordability. Taltavull et al. (2012) used the ratio of housing expenditure-to-household income (HEI)[49] and the upper boundary of housing

[49] The ratio of housing expenditure-to-household income = (unit user cost * housing price * house size) / household income. The unit user cost is composed of risk-free interest rate, property tax rate, maintenance rate, housing depreciation rate, expected housing price growth rate and risk premium of home ownership.

expenditure-to-household income ratio (HEI^{cap})[50] to identify the severity of housing affordability difficulty, and the severity of housing affordability difficulty is categorised in four levels: Non-affordable; severe affordable; moderate affordable; and minimal affordable (Table 6.5). According to Taltavull's research in the period of 2000-2007, Shenyang's HEI was between 0.22 and 0.28, and HEI^{cap} was between 0.58 and 0.63. According to the classification of housing affordability severity, Shenyang had minimal level of housing affordability difficulty. Also, Taltavull indicates that minimal level of housing affordability difficulty brings less risk of housing bubble, which implies that there was less housing bubble issues in Shenyang. Thus, according to the above discussions, both indicators of housing price-to-income ratio and housing expenditure-to-household income ratio implies that Shenyang has less housing affordability issues and less risk of housing bubble.

Table 6.5 The classification of housing affordability severity

Percentage of income	Severity of housing affordability difficulty
$HEI > HEI^{cap}$	Non-affordable
$HEI^{cap} > HEI \geqslant 0.5$	Severe
$HEI^{cap} > 0.5 > HEI \geqslant 0.3$	Moderate
$HEI^{cap} > 0.3 > HEI$	Minimal

Source: Taltavull et al., 2012

6.6. Chapter summary

This chapter presents and discusses the results of the housing demand models. According to the results, the models can explain Shenyang's housing demand well due to the acceptable adjusted R^2, and the income is significant to housing demand at 1 percent level in all the models. From the analysis, the overall conclusion is that housing is still

[50] The upper boundary of housing expenditure-to-income ratio, or the percentage of income, equals to one minus the Engel Coefficient. The Engel Coefficient is the ratio of food expenditure to household income. If housing expenditure to household income is greater than or equal to the upper boundary of housing expenditure-to-income, then housing is not affordable as other basic non-housing expenditures such as clothing and medical service cannot be satisfied. For instance, if the Engel Coefficient of households in the higher-income cohort is 30 percent, the maximal housing expenditure is 70 percent for those households. Conversely, the maximal housing expenditure will be 30 percent should the Engel Coefficient is changed into 70 percent in the lower-income household cohort.

considered to be a *necessity* rather than an *investment* good to most residents in Shenyang. The chapter also analyses each influencing factor of housing demand.

In the income discussion, the chapter analyses the relationship between income and housing expenditures, and this relationship can be explained by the housing reform in different stages during the research period. The increasing ratio of income to housing expenditure shows the transformation of people's notions about housing, from the old system of welfare housing provision to purchasing housing in the market; this can be explained by the abolishment of welfare housing provision and the newly established HPF system. After 2012, the ratio declined as house purchasing became a rational consumption, and people were more cautious on housing buying. It is different from the prior situation of which they blindly followed housing purchasing without considerations on what they actually need for housing. Such rational consumptions declined the housing transactions, indirectly resulting in the over housing supply..

In the housing price discussion, the analysis of housing prices and housing sold explains the effects of the housing reform on Shenyang's housing market. The analysis also concludes that migration, as the main source of the increasing urban population, can explain the increasing housing demand and housing prices.

In the demographic discussion, apart from the household size explanations, the chapter focuses on marriage and the female ratio in the population, discussing how they influence the housing demand of Shenyang. Due to the current circumstances in the Chinese marriage market, families with sons have housing pressures for either themselves or newly married couples. For this reason, the accumulative marriage number may enhance housing demand and housing prices. Meanwhile, the balanced female ratios help to reduce marriage competition, which to some extent can mitigate housing demand and prices.

Then, the chapter also discusses commuting costs and residential expenditures, which may influence housing demand. The analysis of commuting costs implies that the residents' preference for housing is to live far away from the city centre due to the increasing ratios of commuting costs to income. The analysis of residential expenditures explains people's notions about residential expenditures in different stages of housing development.

Finally, the chapter discusses the housing affordability for Shenyang based on housing

price-to-income ratio and housing expenditure-to-household income ratio. The analysis of housing price-to-income ratio shows that the growth of housing price was slower than the growth of household disposable income, and it implies that the housing affordability has been improved in Shenyang. Compared to other large cities, Shenyang's ratio was lower than the other large cities', implying that there was less housing affordability issue in Shenyang. The analysis of housing expenditure-to-household income ratio shows that Shenyang had minimal level of housing affordability difficulty with less risk of housing bubble.

Through the connection with urbanisation, this chapter investigates the housing demand and its influencing factors for Shenyang. The next chapter will present the analysis of Shenyang's housing densification.

7. Results and analysis of housing densification in Shenyang

7.1. Chapter introduction

This chapter presents the results on housing densification and analyses the density changes in different spatial aggregation levels, in order to achieve **RO3** of researching and explaining the changes in housing densities during the research period. Through the analysis, the chapter also discusses housing vacancy problems and the related issues in Shenyang, in order to achieve **RO4**.

7.2. Housing densification with spatial aggregation levels

7.2.1. Housing densification in the entire urban area

Appendices 3 to 8 illustrate the housing stocks and the housing densities in 2010 and 2014 respectively, plus the changes during the period. Table 7.1 presents the housing stocks and densities in the entire urban area between 2010 and 2014, plus the changes during the period. During these four years, urban housing in Shenyang experienced rapid development, which is reflected not only in housing space but also in housing densities. The gross floor area increased by 62 percent, higher than building coverage which saw a 40 percent increase, resulting in changes in the average storey number from 4.38 to 5.06. This implies that the population in Shenyang tends to prefer high buildings, which means that housing densification not only occurs in two dimensions but also reflects vertical growth in the three-dimensional space.

Table 7.1 Housing stocks and densities in the entire urban area in 2010 and 2014

	2010	**2014**	**Growth (rate)**
Building coverage (m^2)	38,910,387	54,556,890	15,646,503 (40%)
Gross floor area (m^2)	170,214,080	276,263,932	106,049,852 (62%)
BCR	0.011	0.015	0.004
FAR	0.047	0.076	0.029
Average storey number	4.38	5.06	
Density increase	0.62		

7.2.2. Housing densification in the central urban core

Table 7.2 presents the housing stocks and densities in the central urban core during the research period, plus the changes. The building coverage and gross floor area increased by 43 percent and 53 percent, respectively. Overall, both items are similar to the entire urban level, which means that new housing in the central urban core tends to lead to a preference for higher buildings, which resulted in an increase in the average number of storeys from 5.18 to 5.52. However, the increase in the gross floor area is smaller than that in the entire urban level, which implies that the new housing constructions tend to occur outside the central urban core. The main reason for this could be that less residential land is available in the central urban core for the new housing constructions. The BCR and FAR, which reflect the housing densities, have very different magnitudes with a gap of approximately 10 times, which means that housing densification occurs in the central urban core and that further housing construction will tend to occur in the suburban areas due to these imbalanced housing densities.

Table 7.2 Housing stocks and densities in the central urban core in 2010 and 2014

	2010	**2014**	**Growth (rate)**
Building coverage (m^2)	21,904,285	31,404,986	9,500,701 (43%)
Gross floor area (m^2)	113,436,215	173,503,076	60,066,861 (53%)
BCR	0.091	0.131	0.040
FAR	0.473	0.723	0.250
Average storey number	5.18	5.52	
Density increase	0.53		

7.2.3. Housing densification in the urban district

Table 7.3 presents the housing stocks and densities in each central urban district during the research period, plus the changes. Overall, housing stocks and housing densities experienced a dramatic increase during the period, especially in Shenhe and Huanggu. In these two districts, the housing stocks increased by over 80 percent in both building coverage and gross floor area, which implies that a massive housing construction was completed during this period. Dadong also had an over-50-percent growth in housing stocks. Tiexi A had a relatively lower growth but was ranked second in housing stocks. Heping had the lowest figures for housing stocks and growth, which implies that housing constructions in this district tend to be saturated. The main reason for this is that Heping has more administrative duties, businesses and public services, with many institutional and commercial buildings and infrastructures, so the residential land is relatively more scarce than in the other districts. Meanwhile, building coverage underwent a negative change with a positive change in gross floor area and a preference for high buildings, resulting in changes in the average number of storeys from 5.02 to 6.09. More high-rise buildings have been built, replacing some old low-rise or medium-rise housing during the period, implying that there is less space available for new housing constructions. The housing densities measured by FAR have increased in all districts, especially in Shenhe, Huanggu, and Dadong. Tiexi A and Huanggu have higher FARs over 1, much higher than the other three districts, implying serious housing densification in these areas.

Table 7.3 Housing stocks and densities in each central urban district in 2010 and 2014

	2010	**2014**	**Changes (ratio)**
Heping			
Building coverage (m^2)	4,798,636	4,427,064	-371,572 (-8%)
Gross floor area (m^2)	24,084,378	26,971,764	2,887,386 (12%)
BCR	0.080	0.074	-0.006
FAR	0.403	0.451	0.048
Average storey number	5.02	6.09	
Density increase	0.12		

Shenhe			
Building coverage (m^2)	3,685,994	7,006,226	3,320,231 (90%)
Gross floor area (m^2)	18,133,680	33,736,793	15,603,113 (86%)
BCR	0.062	0.118	0.056
FAR	0.307	0.570	0.263
Average storey number	4.92	4.82	
Density increase	0.86		
Huanggu			
Building coverage (m^2)	4,478,791	7,600,971	3,122,179 (70%)
Gross floor area (m^2)	23,910,894	44,105,206	20,194,312 (84%)
BCR	0.108	0.183	0.075
FAR	0.577	1.064	0.487
Average storey number	5.34	5.80	
Density increase	0.84		
Dadong			
Building coverage (m^2)	3,619,244	5,519,442	1,900,198 (53%)
Gross floor area (m^2)	16,592,273	27,303,334	10,711,060 (65%)
BCR	0.089	0.136	0.047
FAR	0.409	0.674	0.265
Average storey number	4.58	4.95	
Density increase	0.65		
Tiexi A			
Building coverage (m^2)	5,321,618	6,851,282	1,529,663 (29%)

Gross floor area (m^2)	30,714,989	41,385,978	10,670,989 (35%)
BCR	0.136	0.176	0.040
FAR	0.787	1.061	0.274
Average storey number	5.77	6.04	
Density increase	0.35		

7.2.4. Housing densification in the suburban districts

In order to see the difference between the urban core and the suburban areas, the research also analyses the housing stocks and densities in each suburban district (Table 7.4). From the results, we can see that there have been enormous housing constructions in all the suburban districts, except Sujiatun. The average growth of housing stocks is 100 percent in Hunnan, Shenbeixin, Yuhong, and Tiexi B. Both Hunnan and Yuhong have housing stocks of around 35 million m^2, which is the same as the average housing stock level in the central urban core. Sujiatun has only 10 percent growth in housing stocks with a negative change in building coverage, implying a trend for high building constructions. Housing densities measured by FAR in the suburban area are much lower than those in the central urban area, although a massive housing construction effort occurred during the period. This implies that the focus of housing development has started to shift to the suburban area, where there is sufficient land for residential use, resulting in greater changes in the average number of storeys compared to the central urban core. Also, because the central urban core is completed surrounded by the five suburban districts in terms of locational characteristics, the housing development that occurs in the suburban area can be considered as housing expansion from the urban centre. Meanwhile, because of the dramatic density growth in these suburban districts, housing densification also occurs.

Table 7.4 Housing stocks and densities in each suburban district in 2010 and 2014

	2010	2014	Changes (ratio)
Sujiatun			
Building coverage (m^2)	2,469,122	2,221,736	-247,385 (-10%)
Gross floor area (m^2)	9,127,755	10,053,834	926,079 (10%)
BCR	0.0032	0.0028	-0.0004
FAR	0.012	0.013	0.001
Average storey number	3.70	4.53	
Density increase	0.10		
Hunnan			
Building coverage (m^2)	5,599,674	7,740,469	2,140,796 (38%)
Gross floor area (m^2)	16,736,518	33,464,023	16,727,505 (99%)
BCR	0.006	0.009	0.003
FAR	0.019	0.038	0.019
Average storey number	2.99	4.32	
Density increase	0.99		
Shenbeixin			
Building coverage (m^2)	2,038,716	3,498,670	1,459,954 (72%)
Gross floor area (m^2)	7,500,877	14,926,932	7,426,055 (99%)
BCR	0.002	0.004	0.002
FAR	0.009	0.018	0.009
Average storey number	3.68	4.27	
Density increase	0.99		
Yuhong			

Building coverage (m^2)	5,320,012	7,559,342	2,239,330 (42%)
Gross floor area (m^2)	19,703,566	36,170,579	16,467,013 (84%)
BCR	0.011	0.016	0.005
FAR	0.040	0.074	0.034
Average storey number	3.70	4.79	
Density increase	0.84		
Tiexi B			
Building coverage (m^2)	1,578,578	2,131,685	553,107 (35%)
Gross floor area (m^2)	3,709,149	8,145,487	4,436,338 (120%)
BCR	0.004	0.005	0.001
FAR	0.009	0.019	0.011
Average storey number	2.35	3.82	
Density increase	1.20		

7.3. Further discussions on residential land-uses

Besides housing density, urban residential land is another element that influences housing densification and housing development, and it is always a scare resource in urban development (Cheng, 2010). Wu and Li (2010) indicated that the amount of residential land would increase in line with increasing housing stocks, which helps to mitigate over-high housing density pressures. Cheng (2010, p.14) indicated that "high building density, by providing more built-up space on individual sites, can maximise the utilisation of the scare urban land. Therefore, high building density helps to reduce the pressure to develop open spaces and releases more land for communal facilities and services to improve the quality of urban living". However, Cheng (2010) also indicated that the opposite of the argument was also true. In order to achieve high building density, it is inevitable that massive use will be made of high-rise buildings, which can conversely result in less open space and a congested cityscape. This consequence may happen as high-density development is carried out without appropriate land planning. Therefore, in order to

minimise the adverse impacts of high density, careful urban land planning and appropriate density control are necessary (Cheng, 2010).

In China, according to *The Urban Planning Theory* by Wu and Li (2010), urban land-uses, in order to achieve their best uses, correspond to different urban functions, which have a systematic classification. According to the *Code for Classification of Urban Land-use and Planning Standards of Development Land* (PRC. Ministry of Construction, 2011), the land of a city is divided into two categories: town and country land; and urban land. Urban land refers to the land that has been developed, and the land that has been selected for future development (Wu and Li, 2010). According to the above code, urban land is divided into eight different land-uses, including Residential (R), Administration and public services (A), Commercial and business facilities (B), Industrial and manufacturing (M), Logistics and warehouse (W), Road, street and transportation (S), Municipal utilities (U), Green space and square (G), and Other land (X) (Table 7.5). This land-use classification aims to encourage cities to proceed with reasonable and compatible land-use setting, to avoid functional conflicts between different land-uses, which can accompany urban development, to safeguard public services and to create a liveable environment (PRC. Ministry of Construction, 2011).

Table 7.5 Categories and contents of urban land-uses

Land-use items	**Function contents**
Residential (R)	Housing and related service facilities.
Administration and public services (A)	Administration, culture, education, sports, medical care and health, and other relative institutions and facilities, excluding the service facilities in residential land-use.
Commercial and business facilities (B)	Commercial, business and recreation facilities, excluding the service facilities in residential land-use.
Industrial, Manufacturing (M)	Industrial and mining production workshops, warehouses and ancillary facilities, including special railways, docks and auxiliary roads, *etc*., excluding opencast mining land.
Logistics and warehouse (W)	Material storage, transit, distribution and other relative facilities, including auxiliary roads, parking lots, and logistics yards.
Road, street and transportation (S)	Urban roads, transportation facilities, excluding the roads and parking lots on residential and industrial land.
Municipal utilities (U)	Supply, environment, security and other relative facilities.
Green space and square (G)	Open space, protected green space, squares and parks, and other public open space.
Other lands (X)	Land to be identified

Source: *Code for classification of urban land-use and planning standards of development land* (GB 50137-2011)

Besides discussing urban land-uses and classifications, it is also important to discuss transitions or transformations between different urban land-uses. Wu and Li (2010) indicated that different land-uses can be converted or transformed into each other towards their best uses, in order to avoid excessive urban sprawl and to increase the effectiveness

of urban land. Essentially, urban land-use transitions are caused by human activities, including population changes, transportation, society requirements and economic development, which can influence natural environments and urban forms (Jordan et al., 1990, Liu et al., 2003).

Table 7.6 presents each land-use space in 2010 and 2014 respectively, plus the changes, in the central urban core. The results show that the land-uses of commercial and business facilities (B), and road, street and transportation (S) have experienced huge increases, implying financial and commercial development with appropriate land requirements and corresponding supports for transportation. This land-use process has been supported by the development policy of *Shenyang Urban Overall Development Proposed Plan 2011-2020* (Shenyang Planning and Land Source Bureau, 2013), which aims to promote Shenyang, not only as an economic and financial centre but also as an integrated transportation and information hub in the northeast of China.

Meanwhile, in order to provide sufficient land for such development, other land-uses have had to give concessions, reflected in land-use declines in industrial and manufacturing (M), logistics and warehouse (W), and municipal utilities (U). The residential land-use has declined slightly but remains at the magnitude of 90 million m^2. According to the density analysis, the average number of storeys of housing increases, which enables sufficient residential space in the vertical-dimension but results in housing densification. Thus, considering the considerable growth of housing stocks and the slight decline in residential land-use, it can be concluded that housing densification has been intensifying in the central urban core during this period.

The decline in green spaces is also an indication of unsustainable development. As a result of rapid urbanisation, urban expansion and densification are accompanied by the extensive loss of green lands and agricultural land, which is now converted into residential and other land-uses; this also occurs in other larger Chinese cities (Rousseau and Chen, 2001, Chen et al., 2008). In Table 7.6, we see that about 17 percent of green space has been converted into other uses, which implies that the high-density living has squeezed the green and open spaces that were initially conserved for environmental and social uses. In order to minimise the impact of this decline in green and open spaces, Shenyang has transformed and upgraded 37 squares and parks, including improving their management by upgrading CCTV equipment, increasing green coverage ratios, and providing open-fitness equipment (Shenyang Statistical Bureau, 2014). Even though the

impact of the decline in green and open spaces has been minimised, the supply of the existing green and open spaces does not match the rapid urbanisation with the increasing urban population. Thus, according to the above discussions, due to the rapid urbanisation and economic development goal, Shenyang's urban land-uses tend to be more efficient and more intensive.

Table 7.6 Land-use area and changes in the central urban core between 2010 and 2014

Land-uses (m^2)	**2010**	**2014**	**Changes (rate)**
Residential (R)	91,633,280	89,704,258	-1,929,022 (-2%)
Administration and public services (A)	19,988,291	21,676,879	1,688,588 (8%)
Commercial and business facilities (B)	11,820,569	14,319,360	2,498,791 (21%)
Industrial and manufacturing (M)	51,111,300	39,465,750	-11,645,550 (-23%)
Logistics and warehouse (W)	6,118,293	4,811,817	-1,306,476 (-21%)
Road, street and transportation (S)	4,100,005	4,886,114	786,109 (19%)
Municipal utilities (U)	5,291,078	4,545,914	745,164 (-15%)
Green spaces and squares (G)	39,842,329	33,060,855	-6,781,474 (-17%)

The reason for this land-use pattern is complex. Besides the regional physical conditions and development requirements, the unique Chinese planning system and its development are also considered. In China, the legacy of central planning has generated patterns of urban land-use that differ significantly from other western countries with a market economy (Scarpaci, 2000). The reasons for the differences in urban land-use patterns are: first, the cities under the central-planning system tended to be under-urbanised, so they were usually smaller and had lower population densities than the cities of western

countries under a market economy; second, due to scarce resources, the cities under the central-planning system had fewer qualities of urbanism with high-density CBD and clusters of retail centres, as well as a lack of rudimentary design amenities, compared to western cities; Also, the public and open spaces shaped under the central-planning system were designed liberally for huge public squares and monumental structures. Moreover, Scarpaci (2000) indicated that the cities under the central-planning system displayed a unique "ecological form", in which provisions of urban housing and urban land were noticeably different from the western cities under the market economy. These differences were reflected in the absence of a high-rent and high-rise CBD and the lack of single-family and low-density housing in urban and suburban areas, for most large Chinese cities in the past. Nowadays, fast economic development and rapid urbanisation have brought changes such as high-density CBD, clusters of retail areas, and even single-family housing in suburban areas. These changes also demonstrate the ongoing neoliberal development with more open marketisation and decentralisation in Chinese urban planning. Moreover, for the case of Shenyang, the urban land-use and its transitions coordinate with the city's social-economic development, and the social-economic development is the motivation and the fundamental reason for the urban land-use and its transitions. In detail, Shenyang has set an urban development goal that towards a multi-functional city of integrating its economic and financial role with transportation and information hub, and this transformation needed to adjust and improve its industrial structure from the heavy industry-oriented to the comprehensive industry-oriented. Such adjustments and improvements for the comprehensive industry-oriented required the land-use planning on both the existing urban land and the new developing urban land. This land-use planning has resulted in the changes of the urban land-use area between 2010 and 2014. Meanwhile, such industrial adjustment also required a huge labour force with a massive migration from outside, resulting in the increase of Shenyang's urbanisation level. Correspondingly, new housing constructions with higher housing densities have occurred in both urban and suburban areas. Thus, Shenyang's urban land-use is considered as a result of social-economic development.

Furthermore, according to the statistics (Shenyang Statistical Bureau, 2015), Shenyang has been developing under a rapid urban expansion, which is reflected in the city's land area increasing from 8,515 km^2 in 1984 to 12,860 km^2 in 2014, with a population increase from 5.3 million in 1984 to 8.3 million in 2014. This expansion triggered the rapid development of the suburban areas and the municipal counties of Shenyang. Meanwhile,

Shenyang has promoted urban compactness towards a more sustainable urban development, which the urban population density increased by 2.5 percent from 1,485 person/km^2 in 2010 to 1,523 person/km^2 in 2014. In the aspect of urban land-use, the residential land slightly declines, while the land-use of commercial and business increased. This implies that a potential number of business buildings will be built. Also, the land-use of transportation increased, implying that more constructions of road and street will occupy more land, which will bring higher building densities indirectly. Such land-use transitions will result in urban compactness in the central urban core area. Meanwhile, as the city size expands, more housing and building constructions will occur in the suburban areas, implying an expansion outside the urban core area. Thus, the process of the population density changes and the city size expansions not only implies that Shenyang has experienced fast urbanisation but also shows that the city has development with a combination of urban compactness and urban sprawl simultaneously.

7.4. Further discussions on housing vacancy

In the last section, it was mentioned that urban forms and urban land-use changes are mainly caused by human activities, and such activities are further determined by population changes, and social and economic development. In a particular area, the population changes result in changes in population density, and then the housing densities might change due to the basic living requirements of human beings. However, housing densities in the way we have researched them above cannot accurately reflect the real situations of how much housing space people actually own, because of housing vacancy. Zabel (2016) indicates that housing vacancy is the most important measure of excess supply or demand in the housing market, and vacancy rates above the natural rate[51] are an indication of excess housing supply. In Chapter 6, it mentions that the housing prices has become stable and the transaction volume has declined sharply after 2012, giving an implication of the housing supply over the demand. This section will discuss the housing vacancy in Shenyang to prove that indication of excess housing supply.

[51] The theory of the natural vacancy rate acknowledges the reality that housing markets are characterized by frictions that tend to impede the process of market clearing (in an equilibrium, supply equals demand implying that vacancy rates should be zero). Thus, it is normal a housing markets to have some vacancy, and the level of natural vacancy for a market depends on how responsive (elastic) demand and supply are to economic shocks.

Table 7.7 presents urban housing space per capita, by calculation and by sample survey[52], respectively. From the table, we can see that the housing space per capita obtained by calculation is larger than that obtained by sample survey, and the gap is bigger over time. The gap demonstrates that the housing stocks are increasing very quickly, but the actual space owned by residents is not that large. This implies that many dwellings are vacant. Chi et al. (2015) indicated that the fundamental reason for the high housing vacancy rate in some Chinese cities was fast urbanisation. Due to the rapid urbanisation, a massive number of new houses are built, exceeding the actual housing demand.

Table 7.7 Urban housing space per capita by calculation and by sample survey in 2010 and 2014

	2010	2014	Growth rate
Housing space per capita by calculation (m^2)	33.0	52.3	58%
Housing space per capita by sample survey (m^2)	30.2	31.7	5%

Source: Author's calculation; and *Shenyang Statistical Yearbook* (years vary)

Shenyang's housing vacancy issue has also been identified and investigated by some Chinese researchers. According to a research of evaluation on the suitability of Shenyang's commodity housing vacancy rate by Qi et al. (2016), the vacant level of Shenyang's commodity housing is basically in a controllable range from 2004 to 2014. Meanwhile, the evaluation result shows a high vacancy level of 34.8 percent in 2004 with the natural vacancy rate between 8.8 percent and 17.7 percent, and a slightly high vacancy level of 25.7 percent in 2005 with the natural vacancy rate between 10.0 percent and 20.0 percent. The reason for such high vacancy rates may be caused by the emergence of inflection point in a new round of market cycle, which also reflect the housing reform leading a fast housing development at the beginning of the new century (Qi et al., 2016). From 2010 to 2014, the vacancy rate of commodity housing was suitable from 12.4 percent to 19.8 percent with the natural vacancy rate from 10.0 to 20.0 percent, which shows an increasing trend. This increasing trend of the vacancy rate reflects the housing

[52] Housing space per capita by sample survey is from *Shenyang Statistical Yearbook* in the years of 2010 and 2015. The survey sample is 500 urban households.

vacancy issue in Shenyang and also proves the implication of the over-housing supply in Chapter 6.

Furthermore, the over-housing supply can be explained by the increasing urban population and the housing characteristics. For the case of Shenyang, the urbanisation rate has remained at a high level through time (Figure 5.1), and it shows an increasing trend. In order to meet the living requirements for this population, more urban housing has been built. As discussed earlier, housing is a unique product, with a high cost of supply, durability, heterogeneity, and spatial fixity, which means that it attracts a much higher price and longer decision time than most other products. These two features lead to increasing housing stocks during a certain period. Besides the nature of housing, the increasing housing demand also boosts housing development, and it attracts more developers into the market. Figure 5.5 and Figure 5.6 illustrate the increasing housing investment from various investment sources. Although housing investment started to decline in 2014, housing stocks have been accumulating through time at a high level. Such processes result in the situation where housing stocks outnumber actual housing demand.

Table 7.8 presents housing space under construction, sold, and on sale. The housing space on sale shows an increasing trend, but the housing space sold declines from 2012. This is a sign of suspended housing demand in the market. One reason for this may be the influence of policy on housing purchase restrictions between 2012 and 2014 (**Section 2.5**). Meanwhile, the amount of housing space under construction increases through time, which means that there is a continuous housing supply. Thus, during these years, the housing supply is greater than the housing demand.

Table 7.8 Housing space under construction, sold, and on sale from 2010 to 2014

	2010	2011	2012	2013	2014
Housing space under construction (million m^2)	66.34	76.54	80.40	84.82	82.11
Housing space sold (million m^2)	15.16	19.48	22.01	20.17	13.42
Housing space on sale (million m^2)	4.05	4.73	5.34	7.97	8.90

Source: *Shenyang Statistical Yearbook* (years vary)

7.5. Chapter summary

This chapter presents the housing densification results and discusses the housing densification in each spatial aggregation level of Shenyang. In the entire urban area, the analysis implies that urban housing preferences in Shenyang are for high buildings, and it concludes that housing densification not only occurs at the two-dimensional level but also reflects vertical growth in the three-dimensional space. In the central urban core, the analysis concludes that housing preferences are for high buildings and that new housing constructions tend to occur outside the urban core, due to limited residential land being available. The results for each urban and suburban district show that housing is intensive in each urban district and that new housing constructions tend to shift from the urban area to the suburban area, which is housing expansion. Also, housing densification occurs in each suburban district.

The chapter further discusses the urban land-uses that influence housing densification. The analysis of urban land-use transitions concludes that large-scale use of high-rise buildings is inevitable due to the limited amount of residential land. Also, in order to achieve the development goal under the policy of *Shenyang Urban Overall Development Proposed Plan 2011-2020*, commercial and transportation land-uses underwent a huge increase, and the other land-uses declined correspondingly. These land-use transitions and patterns are considered to be influenced by the legacy of the central-planning system and they also demonstrate the ongoing neoliberal development with marketisation and decentralisation in Chinese urban planning. The thesis also discusses that the urban land-use and its transitions coordinate with the city's social-economic development, and the social-economic development is the motivation and the fundamental reason for the urban land-use and its transitions. Moreover, following the analysis of land area and population density, it is concluded that Shenyang is experiencing a mix of urban compactness and urban sprawl simultaneously.

The chapter also discusses the housing vacancy issue in Shenyang. Between 2010 and 2014, housing space per capita by calculation was bigger than that by sample survey. Also, during this period, the housing vacancy rate shows an increasing trend. It tells us that the actual housing space per capita did not rise much when housing stocks were increasing, implying the housing vacancy in Shenyang. The reason for this is that an increasing housing demand due to rapid urbanisation results in a large number of new house

constructions, and these new houses are hoarded gradually due to increasing house prices and the restriction policy on housing purchases.

The next chapter will conclude the whole thesis and raise policy recommendations. It will also discuss the research limitations and contributions to the research debate.

8. Conclusions

8.1. Conclusions of the urbanisation of Shenyang

The research questions of why urbanisation in Shenyang has increased and which factors influence this urbanisation have been answered through the analysis in Chapter 5. Correspondingly, in order to achieve the research objectives, the thesis defines urbanisation with its economic factors in the literature review, and then it uses regression models to investigate how those factors influence urbanisation. The key research findings are listed as follows.

According to the regression models of urbanisation, GDP per capita, employment share of industry and services, real estate investment and housing investment are statistically significant to the urbanisation rate, so they are the critical drivers for Shenyang's urbanisation. Introducing a lagged urbanisation variable causes the model to function well with higher adjusted R^2. The model results and explanations answer the research questions on how Shenyang's urbanisation has kept on increasing and how economic factors influence it. The comparison analysis shows that Shenyang's urbanisation rate is much higher than the average level of both Liaoning Province and China. Although Shenyang has a relatively low urbanisation rate compared to Beijing and Shanghai, it has a continued capacity to grow up with a relatively high rate of increase.

The thesis discusses migration as an influential factor for the increasing urbanisation. According to the analysis of different types of migration, it is concluded that stable annual net migrations contribute to the increasing urbanisation and they also imply that the *hukou* system controls Shenyang's migration at an appropriate level. The research also analyses two migration sources: migration from Liaoning Province and migration from other provinces. From 2004, the migration from other provinces exceeded that from Liaoning Province. The results reflect the fact that the opening-up of the economy stimulated surplus labour forces to move from less-developed areas to more-developed areas. Shenyang has the capacity to attract migrants from other areas either inside or outside Liaoning Province. This attraction can help to achieve the planning goal of building Shenyang as the economic centre in the northeast of China (Shenyang Planning and Land Source Bureau, 2013). The thesis also discusses Shenyang's outstanding medical and educational resources, which attract migrants to settle in the city. This section achieves the research objective of investigating migration and discussing the *hukou* system as control of migration.

As housing investment is statistically significant and positive to the urbanisation rate in the models, the research carried out further analysis of the housing investment in Shenyang. Overall, the increasing housing investment throughout the research period not only explains the booming development in Shenyang's housing market but it also confirms housing as the primary driver of Shenyang's urban economy. Through the analysis of different investment sources, it is concluded that rapid housing development is supported by the domestic economy in Shenyang. The decline in housing investment in 2014 shows a recession signal in Shenyang's housing market, and the reasons for this are various, including tightening mortgages from banks, increasing supply with suspended demand, and overdrawn purchasing power from consumers. On the other hand, imbalanced relationships between demand and supply and overdrawn purchasing power also caused housing stocks to accumulate. Moreover, foreign direct investment declined from 2013, implying that foreign investors anticipated the housing bubble and decreased their investment. This section achieves the research objective of investigating housing investment and how it affects Shenyang's housing development.

Furthermore, the thesis focuses on the investment of SOEs and the investment of shareholding companies within domestic investment. It discusses how the vast profits from the housing business pushed many SOEs and some shareholding companies that used to be SOEs to join the housing market. The huge increase in investment during the research period implies that the SOEs converted their role from one of housing allocators to that of housing developers through the housing reform. This can be explained by their unique advantages for housing development compared to other types of developers. Although the welfare housing provision was abolished in the housing reform, SOEs and other work units were allowed to build houses on the land under their control and to sell them to their employees at lower prices than commercial housing. Most of these houses were approved as affordable housing, which benefits from some concessions on government charges, meaning that the land-use fees were much cheaper than for commercial housing (Wang et al., 2005). Deng et al. (2011b) find that SOEs purchased a large amount of residential land for housing development between 2008 and 2010. Due to their political connections and institutional characteristics, SOEs can easily gain financial support from banks and other preferential treatment on land bidding (Deng et al., 2011b, Wu et al., 2012). Besides the housing development by SOEs themselves, housing co-operatives were formed between SOEs and property developers. Apart from selling to the employees, some houses were sold on the market (Wang et al., 2005). The

evidence above explains why SEI underwent such a rapid increase during the research period.

8.2. Conclusions of the housing demand of Shenyang

In Chapter 6, the thesis used housing demand models to answer the research questions on which factors influence housing demand in Shenyang and how those factors influence housing demand. The key research findings are listed as follows.

The housing demand models assume that the market is in equilibrium and in disequilibrium. The high adjusted R^2s imply that the housing demand models work well for Shenyang's case. The adjusted R^2s in the disequilibrium models with partial stock adjustment are higher than those in the models without partial stock adjustment, which implies that the models with partial stock adjustment can explain more of the sample variation of the housing stock. Meanwhile, involving the demographic variables and commuting and residential expenditure delivers a higher adjusted R^2 in the models with partial stock adjustment and in the models without it. According to the model results, the income elasticities are between 0.430 and 0.663, which are similar to other Chinese housing demand studies. Thus, it is concluded that the income elasticity is inelastic, which implies that housing is currently a basic life necessity rather than an investment good for Shenyang's residents.

The thesis also further discusses each factor involved in the models. In the income section, the research focuses on the relationship between income and housing expenditures. Due to the long-term influence of the old welfare housing provision system, even though the housing reform started in 1998, Shenyang's residents' notions on housing were conservative, which resulted in very little income being spent on house purchases at the beginning of the research period. On the other hand, in this stage, there were few new residential communities with newly constructed housing, so there were limited choices in the market for consumers. With the ongoing housing reform and the rapid real estate development, housing consumption became common and more affordable for the residents due to the new HPF system. This resulted in a peak in the annual ratios of housing expenditure to income during the first decade of the new century, which means that people were willing to spend money on housing. In turn, such high ratios reflect the increasing housing demand, which also attracts more investment into Shenyang's housing market, resulting in increasing housing stocks annually. All this is evidence of the

prosperous development of Shenyang's housing. After the first decade of the 21st century, the housing market has developed to be regulated and competitive with well supervisions, and people did not blindly follow for housing purchasing without considerations on what they actually needed. The housing sales have declined, and it resulted in over supply of housing.

The price elasticity for the case of Shenyang is between -0.028 and -0.402, and negative to housing demand. The results are similar to those of other Chinese housing demand studies. Thus, it can be concluded that housing prices are inelastic to housing demand, which means that changes in house prices do not significantly influence the housing demand of Shenyang. Overall, the housing prices show an increasing trend as in many other large Chinese cities, including a steady increase phase in the first half of the period, and a rapid increase phase in the second half of the period. The drop in 1997 implies that the housing market was affected by the housing reform, and that consumers were worried about the influenced market. It reflected cautious purchasing by consumers, resulting in a price drop. The ongoing housing reform provided an institutional impetus for housing development, resulting in an increase in housing transactions. These increasing house transactions also provide evidence for the prosperous development of Shenyang's housing in the first decade of the new century. The rapid increase in housing prices reflects a situation of demand over supply, and the fundamental reason is the rapid urbanisation process. This fast urbanisation was mainly a result of the steady and huge migration and it led to a rapid increase in the urban population. Due to the unique *hukou* system in China, some migrants without urban household registration could not enjoy state-sponsored affordable housing at a lower prices, so they had to purchase commercial housing on the market, which caused the housing prices to increase.

The average household size, as the demographic variable, is not statistically significant to housing demand, which means that the household size does not have much influence on housing demand in the statistical sense. However, for the case of Shenyang, the annual average household size declined with the increase in housing demand, which is supported by the theoretical relationship studied by Mesthrige Jayantha and Lau (2008). Because the decrease in household size involves a situation where the existing household members leave to build a new household, the new household has a separate housing requirement. Thus, it is concluded that household size has a substantial impact on housing demand, even if it is not significant in the statistical sense. Moreover, the research also analyses

how marriage and gender balance as demographic factors may influence housing demand. Due to marriage competitions, households with a son would increase their savings rates in the hope of improving their son's odds of finding a wife, and changes in gender ratios may influence such marriage competitions. The analysis shows that a gradually balanced gender ratio can help to control the excessive increase in housing prices and the excessive requirement of housing sizes indirectly, as the competitions within households with sons in the marriage market tend to be mitigated.

The thesis also discusses the relationships between commuting costs, residential expenditures and housing demand, even though they are not statistically significant in the models. The analysis shows that the ratios of commuting costs to income were increasing overall. This means that people spent more on commuting during the research period, which implies that the preferred housing location is outside the city centre. This viewpoint can also be proven by the housing expansion towards the suburban areas of Shenyang, which was discussed in Chapter 7. The analysis shows that the ratios of residential expenditures to income were fluctuant. This fluctuation can be explained by the housing reform and market development, according to the study by Wu and Yang (2008). In the beginning, as housing was still provided as a type of welfare, people were able to spend more on residential expenditures without housing financial difficulties. In the middle phase, the housing market became gradually mature after the housing reform, so the ratios were steady. In the final phase, because house purchases and related housing consumptions became rational for most families, the ratio of residential expenditures to income saw a slight decline.

8.3. Conclusions of the housing densification of Shenyang

The research question about housing densification in Shenyang in a spatial sense has been answered through the analysis in Chapter 7. In order to achieve the research objectives, the thesis reviews housing densification and density measures, and then it uses spatial aggregation with GIS applications to investigate Shenyang's housing densification. The key research findings are listed below.

The thesis applies spatial aggregation to divide Shenyang into different spatial levels, including the entire urban area level, the urban core area level, and the urban and suburban district level. According to the analysis, the housing is intensive in each urban district and the new housing constructions tend to shift from the urban area to the suburban area. Thus,

it is concluded that housing densification and expansion have occurred simultaneously in the central urban core and the suburban areas of Shenyang, and it is highly likely that the processes will continue due to future population growth. In all the spatial aggregation levels, the analysis shows that housing densification not only occurs at the two-dimensional level but is also reflected in vertical growth in the three-dimensional space, which implies that there is a preference for high buildings. This section achieves the research objectives of investigating Shenyang's housing densification and explaining housing density changes.

The thesis further discusses urban land-uses and land-use transitions. The analysis shows that residential land has not received sufficient support as other land-uses have, such as business and commercial land-use, and administration and public land-use. This can be explained by the fact that Shenyang has shifted its role from a traditional industrial base to an economic and financial centre, requiring more land for business and administration services. The insufficient land supply also triggers higher residential buildings on new housing constructions. Land-use development is considered to have been influenced by the legacy of the central-planning system and ongoing neoliberal urban development with marketisation and decentralisation. Furthermore, the analysis of land area and population density implies that Shenyang is experiencing a mix of urban compactness and urban sprawl simultaneously.

The thesis also analyses the housing space per capita by calculation and by sample survey. The large gap in the growth rates of the two items reflects the fact that the actual housing spaces that people own are far away from the housing stocks provided on the market. This highlights the issue of housing vacancy in Shenyang, which indirectly implies that the housing supply was much greater than the housing demand by the end of the research period. This can be explained by the nature of housing and the process of housing development. Because housing is a unique product with a high cost of supply, a long period of durability and fixed location, it attracts high prices and longer decision times. The duration of the whole process from producing to selling is difficult to predict, which easily causes stock hoarding. Besides, in the sense of macro-economics, increasing housing demand triggers increases in housing prices, and more developers willing to invest flood into the market and increase the quantity that they wish to produce. Both reasons have resulted in gaps between housing space sold and on sale, and even the increase in the number of housing spaces under construction.

8.4. Wider perspectives for the northeast China

Overall, Shenyang has been experiencing a steadily increasing urbanisation since the 1990s, and from the analysis it is concluded that the economic growth with the increasing employment share and GDP drives the urbanisation significantly. Moreover, due to Shenyang's geographic importance and economic role in the northeast China, the increasing trend of urbanisation will last in the future, and Shenyang's urbanisation level will stay at the top ranking in the northeast China. However, compared to other large Chinese cities located in the south and coastal regions, such as Beijing and Shanghai, Shenyang's urbanisation level is still relatively lower. As discussed in thesis, economic growth is the fundamental reason for increasing urbanisation in the long term. The increasing urbanisation drives housing demand to increase, and then it leads to new housing constructions, finally resulting in housing densification. Therefore, for the case of Shenyang, the fundamental reason for such urbanisation gap compared to other large cities is the relatively lower level of economy, which the performance of Shenyang's GDP is far from those cities. This economic gap also reflects in many other aspects, such as relatively lower income and housing price.

At the beginning of the opening-up, most large cities had the similar economic level due to the implementation of planned economy. At this stage, compared to other regions, the large cities in the northeast China had high level economic performance because most heavy industrial enterprises with large projects located in those cities. However, since the economic reform, the development of northeast region has taken a back seat to economic activities in the burgeoning east and south coastal regions. The proportion of the northeast region's industrial output as a share of the national total has declined from 16.5 percent to 9.3 percent. The reason for the sluggish economic performance is the unsuccessful economic restructuring from the heavy industry-oriented economy to the comprehensive economy in the northeast region. For example, the SOE reforms that aimed to mitigate fiscal pressure of the central government, have resulted in a massive number of employees to lose their jobs. These unemployed people could not find new jobs soon, and they had to receive minimum-income social security. In the whole northeast region, 6 million urban residents receive the minimum-income social security, and they accounted for 25 percent of the urban poverty population in the country. As a result, the local governments had to rearrange the fiscal budgets for the unemployment, which affected the original

economic development plans in many cities. In the long term, it has resulted in the relatively lower economic performance in the northeast region, and people's income was lower compared to the cities in the south and coastal regions. The lower economy was also reflected in some cities' housing market recessions in the northeast China. Housing demand in the northeast region is not as high as the demand in the south and coastal regions, which housing is still necessity for most people in the northeast region. This is also related to the relatively lower economic level, which most people with less income have no financial capacity to invest more houses. This mitigates the housing demand in the market indirectly, so the housing prices in the northeast region are lower than the cities in the south and coastal regions. Thus, the issues of housing affordability and housing bubble in the northeast region are less severe.

In conclusion, the economic reforms in the northeast region have not been implemented as rapidly and effectively as the reforms in the south and coastal regions, resulting in the economic gap compared to the south and coastal regions. This economic gap influences the urbanisation and the housing demand of Shenyang and other northeast cities, finally resulting in different spatial patterns of housing, compared to other cities in the south and coastal regions.

8.5. Research limitations

In this thesis, there are some research limitations that might influence the findings and analysis. Overall, data availability was a common limitation for this research. The initial research plan aimed to investigate urbanisation, housing demand and housing densification in the same research period between 1995 and 2014. However, the data collection through the fieldwork for housing densification did not achieve the data requirement of the initial plan. In addition, the thesis only uses a multiple linear regression method to estimate the urbanisation and housing demand for Shenyang's case, because the method with twenty-year time series data shows that the models work well with acceptable adjusted R^2. The number of independent variables for both models is not large, as they are also restricted by data availability. For predicting future situation, large sample size can give more precise results of variable coefficients, and the prediction will be more accurate than the models with small sample sizes. Also, small sample size brings difficulty and inaccuracy to apply different methods for time series analysis. For the case of Shenyang, the sample size for regression is not large, which cannot enable to use other

advanced regression methods. If more variables are archived and can be accessed in future, more regression methods can be attempted, such as logistic regression, the ARMA model and the ARIMA model. The discussions below present the details of the research limitations for each topic.

For urbanisation, the research has examined housing investment as a significant variable to urbanisation. In the Chinese context, housing investment contains DI, HTMI and FCI. DI is mainly composed of SI, PI, SEI, and other investment types that appear in the different periods. According to the analysis, SEI represents the investment by SOEs, and SOEs have several advantages with regard to housing development. However, due to the reform of SOEs, many have been transformed into shareholding companies, but they still inherit the legacy of SOEs. Due to this complex situation, the research cannot fully analyse SOEs' influence on housing investment, as the data source cannot provide specific figures for those shareholding companies that used to be SOEs. Also, in the *Shenyang Statistical Yearbooks*, housing investment is categorised from the year 2002, so we cannot access data for the full research period from 1995. Thus, this thesis has discussed SOEs' influences on the housing market only by considering SEI, which could weaken the conclusion on SOEs' role in the market.

For housing demand, the research initially attempted to use quarterly and monthly data to examine housing demand. However, the quarterly and monthly data are only available from 2005, which does not cover the same research period as that used in Chapter 5 on Shenyang's urbanisation – from 1995 to 2014. Thus, the research used the alternative annual data instead. Furthermore, in the housing demand, it was initially attempted to use the rental costs and residential energy use as two individual variables in the models, because they have been commonly applied in housing models. However, the data on these two items were not collected or recorded in the statistical yearbooks, so the initial plan was not feasible. Instead, residential expenditure, which covers rents, energy expenses and other residential expenses as a total, was used as an independent variable in the models. This replacement may affect the variable significance of rents and energy in actual existence, and it also may affect the other variable significance in the models due to multiple regression. Due to those data issues, the housing demand models could be further improved.

For housing densification, the research initially attempted to analyse the housing densities in each spatial aggregation level from 1995 to 2014, covering the same research period

as urbanisation and housing demand. However, because the GIS database of Shenyang was set up only a few years ago, only the annual data from 2010 and 2014 were available. Moreover, the GIS database can only present the housing space data accurately to land cell level, which means that it only provides the total floor space of all the residential buildings in a land cell, not individual building information. This can result in the situation where two land cells have the same density with different building types and arrangements. Also, the average building storey number is calculated by BCR and FAR, which has deviations compared to the mean calculation of using number of building storey in actual existence. However, the data of number of building storey is not available in practice. Furthermore, even though the land cell level is much more accurate than the city level and the central urban core level, it can be improved to a more accurate level with various details including building types, number of building storeys, dwelling number, *etc*. Furthermore, the data on land-uses were also insufficient, as they only covered the central urban core in 2010 and 2014. Thus, the shifts between residential land-use and other land-uses cannot be analysed comprehensively.

8.6. Policy implications and recommendations

8.6.1. Recommendations on migration with the concerns of the *hukou* system

According to *Shenyang Urban Overall Development Proposed Plan 2011-2020*, it is estimated that the Chinese urban population will increase by 2 million, reaching 7.25 million in 2020. The thesis has analysed migration as a potential influencing factor of urbanisation. Thus, how to settle and house the huge increase in the urban population is a challenge for Shenyang. Besides housing, other social issues such as employment, medical care and health, education and other types of social welfare, will be under pressure and face challenges. As a significant institutional barrier, as discussed in Chapter 1 and Chapter 5, the *hukou* system not only controls the excessive migration flooding into the city but it also ensures that people with *hukou* status enjoy the corresponding welfare. Generally, gaining a *hukou* status involves a time-consuming application process with strict conditions, which indirectly brings difficulties for some migrants. Thus, for the *hukou* application, it suggests that the local authorities should enhance the effectiveness of the application process. Furthermore, as Shenyang is facing problems related to aging population like many other large Chinese cities, the *hukou* policy should relax residency requirements to attract more young migrants, which will sustain vitality and strength of

the labour market. In a long term, it will sustain local property markets and promote economic growth.

Zhou and Cheung (2017) indicate that Chinese policymakers have recently focused on the housing problems in large cities due to huge migrations rather than other social issues; in particular, they have paid less attention to the education needs of migrants. For example, nowadays, migration families are most concerned about the *hukou* system and how they can settle and promote their children's education. Children of migrants who are born in cities become 'migrant children' by birth, and these families face social exclusion, being socially isolated or given a migrant label. Many of those children may move frequently to several different locations for the working requirements of their parents, so these children may not be integrated into schools and communities well. To resolve this issue, migrant schools were built in many cities in the mid-1990s as an educational alternative to public schools for the migrant children. Therefore, for the case of Shenyang, due to the stable magnitude of the migration figure, a policy recommendation is to fund and build more migrant schools, and to give more consideration and choices to migrant families for their children's education. If migrant families are given more choices between public schools and migrant schools, most families will enrol their children in public schools due to the higher qualities of the teaching teams and the school facilities. However, most public schools require additional fees and extensive mandatory paperwork for migrant children, and some of them charge higher fees illegally (Zhou and Cheung, 2017). Thus, policy makers need to pay more attention to these issues, for example by prohibiting higher or additional fees charged for migrant children in public schools, lowering the qualification threshold for migrant children to enter public schools and funding migrant schools with better teaching teams and facilities.

Besides the education considerations for migrants, there are policy suggestions for the government. The core aim of the *hukou* system is for local governments to provide public services to residents. However, although they receive fiscal allocations from the central government, local governments still have a heavy burden of local expenditure. Meanwhile, local tax revenue is often much less than their expenditure responsibilities (Lu and Wan, 2014). For these reasons, the policy recommendations for migration and the *hukou* system for Shenyang's case may consider the following two points: first, basic public services in the urban, suburban and rural areas should be promoted simultaneously. This will moderate the situation whereby massive numbers of migrants rush into the

central urban area and it will relieve pressure on existing public services. Second, a balanced fiscal arrangement between the central government and the municipal government should be implemented in order to relieve the heavy burden of local expenditure on public services.

8.6.2. Recommendations on further housing development

The thesis concludes that housing is still currently a life necessity rather than an investment good for Shenyang's residents currently, so controlling housing prices at an affordable level for most people is a challenge for both the local government and the stakeholders in the housing industry. The first recommendation is that the existing HPF system can be further improved, which would allow different income groups to afford housing. In China, the allowance of the HPF varies by different employment circumstances in a particular city. The local authority of a city decides the minimum and maximum contribution rates from an employee's monthly salary, and the allowance is paid by both employee and employer monthly. Generally, employees who work for SOEs and institutional authorities receive a larger allowance than people with other types of employment. This disparity causes different purchasing powers for housing, and the same or similar house prices can be accepted or not by people with different types of employment. Thus, the policy recommendation is to consider the disparity in the HPF and to balance the gaps between different types of employment.

According to the analysis, although people are willing to spend more on housing expenditure with income growth, increasing house prices still bring difficulties with accessing housing, particularly for low-income families. Thus, the second recommendation is to help low-income families with affordable housing programmes. For those low-income families, affordable housing built with government fiscal support has been identified as key to helping them afford housing. The analysis also shows that the hoarding of housing stocks has appeared in recent years, indicating a trend of supply over demand. Considering the above, two recommendations are considered to solve the issues: first, the municipal government should conduct further development of affordable housing to help low-income families, which requires that the government directs more investment to affordable housing projects, and it also needs to lower the threshold of eligibility requirements to let more people apply for the affordable housing. Meanwhile, the supervision authorities must pay attention to inspection to avoid improper transactions

of affordable housing in the market; second, some of the existing unsold housing stocks could be converted to affordable housing, which would not only relieve the pressure of further affordable housing provision but also release existing housing stocks. The difficulty of this solution is that the developers would have lower profits due to the lower prices of affordable housing, so local government needs to negotiate with the developers to make a deal for the transformations.

As mentioned in Chapter 2, Shenyang's housing market showed a recession after the policy implementation of housing purchase restriction. To activate the market and boost purchasing power, the municipal government issued *The Notice of Releasing the Purchase Restriction of Housing* in September 2014, which resulted in increasing housing prices caused by housing speculation. The speculation issue also appears in many large cities in China. Although housing is a basic life necessity rather than investment good for most Shenyang's residents, a few people with higher financial capacities buy more houses for speculation beyond normal investment of housing. In order to avoid more housing speculations, a new property tax for residential housing needs to be proposed for those cities, and Shenyang as well. Property tax is a large and complex topic in China, and it operates under two different systems[53]. Property tax covers different aspects such as residential property, business and commercial property, and industrial property. For this section the recommendation only focuses on the property tax on residential housing. It is recommended that Shenyang benefits from the experience of other larger cities that have already carried out property taxation experiments. For example, Shanghai exempts first-time house buyers from property tax and it provides 60m^2 relief per person on property tax for families with the local *hukou* status who buy their second or more house. The tax rate for the second or more house is proposed to be 0.4 percent per year. So, for example, if a family with the local *hukou* status already owns a 150m^2 house and they buy a second house at 30,000 yuan/m^2 and 110m^2 floor area, the property tax per year is calculated as (150 + 110 – 60*3) * 30000 * 70% * 0.4% = 6720 yuan. The tax base is calculated as 70 percent of the housing trading price shown above. This idea could be introduced to Shenyang's property tax proposal, adjusting housing area per person and some

[53] In China, the existing property tax structure has been enacted and implemented for decades with few changes, and it is considered out of date and has many problems. Domestic and foreign entities operate under two different taxation systems. The domestic land users pay building tax and urban land-use tax, and foreign land users pay urban real estate tax without paying land tax. The reason is the government offers tax incentives for foreign users to attract foreign direct investment.

coefficients, which will set a barrier to housing speculators by paying tax annually. Moreover, considering the social issues for young married people discussed in Chapter 6, that the female side raises the requirement that the male side must have housing before marriage, the exemption options can expand to families whose children are ready for marriage. These recommendations need supervision from the relevant authorities to avoid tax fraud. Meanwhile, property tax can also provide a more stable and reliable revenue stream for local government to fund urban constructions and social programmes. If the tax is used to fund affordable housing programmes, it can be seen as a type of sustainable recycling for Shenyang's housing development.

The above three recommendations, dealing with the HPF system, affordable housing and property tax on residential housing, aim to control the increasing housing prices, to make urban housing more affordable for residents, and to avoid housing speculation. If those expectations happen under regulation by the government and supervision by the authorities, the housing prices will be controlled at a reasonable level for most residents in Shenyang. Then, the housing market will be positively active with an increasing number of housing purchases. This can solve gradually the issues of hoarding housing stocks and housing vacancy discussed in Chapter 7. Meanwhile, if the existing housing stocks can be consumed gradually, there will be less pressure on new housing constructions. As a result, in the long-term, the housing densification in Shenyang may be controlled, as the housing densities will not increase much further and more urban land will be planned with functions other than residential use. In this way, urban compactness and urban sprawl can interact with each other, resulting in a much more efficient urban land-use and avoiding over-expansion.

8.6.3. Recommendations on urban sprawl and high-density living

According to the analysis of the urbanization and the housing density, the processes of the population density changes and the city size expansions not only imply that Shenyang has experienced a fast urbanisation but also show that the city has development with a combination of urban compactness and urban sprawl simultaneously. Thus, the policy recommendation considers both urban expansion resulting in urban sprawl and urban compactness resulting in high-density living.

Urban sprawl in western world is commonly characterized by a low-density, leapfrog land-use pattern of residential communities that reduces public open space. In contrast, urban sprawl in large Chinese cities features a low-density industrial development zones and college towns (Yue et al., 2013). For most large Chinese cities, urban sprawl may have been driven by the failed implementations of several policies, such as farmland preservation, urban planning controls, and land market regulations. For the case of Shenyang, more housing construction tend to occur in the outside urban area, as the residential land has declined in the central urban core area. As a result, more farmland in the suburban and rural area has to be taken to provide more land for housing development, which will result in urban sprawl in the future. For this consideration, a farmland preservation policy with specific zones should be formulated by the government, and this policy should be complied with the basic farmland preservation regulations by the central government. Furthermore, urban sprawl may also associated with too general master plans. For Shenyang, *Master Plan of Shenyang City 2011-2020* only set targets of general urbanization level and urban land scale for construction, but there is no details provided for housing development such as built-up boundary and housing density limits. Even though Shenyang Urban Overall Development Proposed Plan 2011-2020 set a target of housing space per capita, it does not provide further information of housing density limits for different urban and suburban districts. Such too general planning will result in the imbalanced housing arrangements among the city districts and urban sprawl developing outside the existing urban areas. Thus, a detailed master plan is suggested to formulate with providing specific planning targets for housing constructions for all the city districts.

The urban compactness caused by the housing densification in the central urban core leads to high-density living, so urban environmental issues cannot not be ignored. Related to this thesis, environmental concerns include the decline of green and open spaces in urban areas, the emissions from an increasing number of private cars, the heavy usage of coal for heating, and the massive disposal of living waste. Therefore, the recommendations below will suggest how to minimise the impacts of high-density living on the environment.

In Chapter 7, the analysis shows that Shenyang has transformed and upgraded some of the existing open squares and parks to deal with the decline of green and open spaces. This is considered to be an alternative way of transferring other land-uses to green and open space; however, the other land-uses are not sufficient due to the limited amount of urban land. Thus, understanding how to make efficient use of the existing green and open

spaces will be an urgent task, and this can be achieved through two actions. First, the authorities can continue to transform and upgrade the existing open squares and parks in the whole city area by establishing more fitness facilities, replacing the old and damaged facilities for public use, while managing and supervising them to maintain their quality. Second, green strips can be maintained alongside the roads and streets, maintaining their quality away from pests and diseases. Environmental conservation not only relies on government actions, but also needs support from the residents. Public service advertisements through social media could help to enhance the awareness of residents with regard to environmental protection.

The existing high-density living in Shenyang affects the environment, mainly due to the heavy usage of coal for heating, massive vehicle emissions, and the huge pressures of waste disposal. Shenyang now relies on coal-fired boiler stations for heating. By 2014, the city had 801 coal-fired boiler heating stations for the whole city's heating, and those stations produce a considerable amount of emissions every year. The government has already shut down some small stations and merged them to big stations covering a larger area, reducing emissions by around 6,000 tons. With sustainability concerns, the shift from coal burning to new sustainable energy usage for heating is an alternative option for Shenyang. For the issue of vehicle emissions, a quick solution would be to control the number of petrol and diesel vehicles and to encourage the use of natural gas and electric vehicles. For the issue of waste disposal, the city should improve the existing waste management strategy, involving all key stakeholders and examining the advantages and disadvantages of all practical waste management techniques. In most Chinese cities, abandoned waste dumps (landfills) are the main bodies of waste disposal; this should be questioned and they should be tested to determine whether they affect public health and have an impact on ground and surface water resources. Considering this situation, it is suggested that Shenyang prepares an inventory of the sites, and stops building this type of waste dump, instead developing incineration facilities.

The development of waste recycling programmes will relieve the pressures of sustainable waste disposal and help to boost recycling rates and the recycling industry. Waste sorting is the beginning and the most essential part of wasting recycling. In most areas of Shenyang, household waste is still dealt with in the traditional way where it is separated at the waste dumps. To implement waste recycling programmes systematically, Shenyang implemented a pilot waste sorting scheme in 59 residential communities in 2013, and it

continued to establish these in another 233 residential communities in 2014. By the end of 2014, waste sorting was available for 15 percent of the residential communities in Shenyang, but the actual use of wasting sorting is still far from the expectations (Shenyang Statistical Bureau, 2014). Thus, besides adding more recycling bins in residential areas and public spaces, communication can be used to raise people's awareness of waste recycling. Communication covers the following aspects: first, educate the community, using social media or other ways to promote recycling programmes and to increase participation, sharing valuable information about acceptable recyclable materials. Second, set goals and benefits, explaining which achievements and benefits can be enjoyed by the residents and businesses, in order to make them understand and realise the importance of waste recycling. Third, focus on schools, educating the younger generations to have an awareness of waste recycling at an early age, and encouraging recycling behaviours in future, regardless of location.

8.7. Contributions of the thesis

The existing studies on Chinese urbanisation and housing development are mostly confined to qualitative analysis and they focus on a nationwide scale or well-known cities like Beijing and Shanghai. In recent years, urbanisation and housing have developed rapidly in China, especially in large cities. However, there are few studies focusing on the cities or areas in the northeast China. Shenyang, the capital city of Liaoning Province and also the biggest city in the northeast China, has geographic and economic significance in the northeast China, which has attracted attention to its development. With a comprehensive review of the literature on urbanisation and housing development, this thesis systematically investigates the urbanisation, housing demand and housing densification for Shenyang, which helps to fill the literature gap and also provides thinkable research threads for similar and related research topics.

With regard to urbanisation, firstly, this thesis not only fills the gap in the existing literature about the effect of housing investment, working with other economic drivers, on the urbanisation model for large Chinese cities, but it also provides an effective application of the static and lagged urbanisation models for a single city in China. Secondly, it enriches the literature on the impacts of the Chinese unique household registration system (the *hukou* system) through migration control on urbanisation, and it also uses three types of migration to analyse the causes and consequences of Shenyang's

migration in recent years. Thirdly, it fills the gap in the existing literature about how different sources of housing investment work in the housing market for a single city in China, explaining the causes and consequences, and it also confirms the role of SOEs in Chinese housing development.

For housing demand, firstly, the research method applies the static and lagged housing demand models with economic, demographic and other influencing factors for the case of Shenyang, which fills the gap in the literature of using housing demand models for a single city. Secondly, it discusses how marriage and an imbalanced gender ratio can influence housing demand and prices, and it also reveals how the social pressures of housing purchases trouble single men when they become old enough to marry. This fills the literature gap with regard to marriage and housing demand, and it provides a new research thread with consideration of demographic and social issues for further housing research.

For housing densification, firstly, through a comparison of different housing density measures, the thesis confirms building coverage ratio (BCR) and floor area ratio (FAR) as the two main measures for housing density measurement for the Chinese context. Secondly, the thesis introduces the spatial aggregation method with GIS software to divide the city into several spatial levels, and it demonstrates the process of housing density and housing stock changes with the GIS graphics at each spatial aggregation level. The thesis helps to fill the literature gap of the application of the spatial aggregation method with GIS software to a single city. The findings based on the GIS graphics also illustrate the trends in Shenyang's housing stocks and densities, which provide a theoretical basis for new housing constructions in future to avoid imbalanced distributions in all districts.

8.8. Future research directions

This thesis has investigated Shenyang's urbanisation, housing demand and housing densification. With the key findings, it provides some new research threads for future research related to each topic.

Firstly, the thesis discusses how migration is an influential factor for Shenyang's urbanisation and how the *hukou* system controls migration at an appropriate level. It implies that Shenyang's urbanisation is not only a spontaneous result of rural-urban

migration but is also shaped by political behaviour. For future research, a new thread would be to investigate how migration policies influence Shenyang's urbanisation. Also, an improvement would be to divide migrants into different groups to analyse their behaviour.

Secondly, the thesis investigates Shenyang's housing demand with a limited data source, and it is concluded that housing is still a necessity rather than a commodity for Shenyang's residents. Future research could enrich housing data to involve more housing variables in the models and analyse their influence on housing demand. Also, an improvement would be to divide people into different income groups to investigate their housing demand.

Thirdly, the thesis investigates Shenyang's housing densification using a GIS system. With different spatial aggregation levels, it is concluded that housing densification and expansion have occurred simultaneously in the central urban core and the suburban areas of Shenyang. Considering housing vacancy, an improvement would be to investigate the actual use of the existing housing stocks, which could inform the quantity of future housing constructions in order to balance the demand and supply of housing.

Moreover, another improvement for future research would be to conduct a comparative analysis of those topics between Shenyang and other Chinese cities with similar land areas and population. Using comparative research methods would help deliver more objective and clear conclusions.

9. References

ALBOUY, D. & LUE, B. 2015. Driving to opportunity: Local rents, wages, commuting, and sub-metropolitan quality of life. *Journal of Urban Economics,* 89**,** 74-92.

ALKIRE, S., CHATTERJEE, M., CONCONI, A., SETH, S. & VAZ, A. 2014. *Poverty in Rural and Urban Areas-Direct comparisons using the global MPI 2014* [Online]. Oxford Poverty & Human Development Initiative (OPHI). [Accessed 12/10/2015 2014].

ALONSO, W. 1964. Location and land use. Toward a general theory of land rent. *Location and land use. Toward a general theory of land rent.*

ANAND, S. & SEN, A. 2000. Human development and economic sustainability. *World development,* 28**,** 2029-2049.

ANDERSON, N. 1964. *Our industrial urban civilization,* Asia Publishing House.

ANNEZ, P. & BUCKLEY, R. M. 2009. Urbanization and Growth (Commission on Growth and Development). Washington, DC: World Bank.

ARKARAPRASERTKUL, N. 2012. Urbanization and housing: socio-spatial conflicts over urban space in contemporary Shanghai. *Aspects of Urbanization in China Shanghai, Hong Kong, Guangzhou*.

BAJARI, P., CHAN, P., KRUEGER, D. & MILLER, D. 2013. A dynamic model of housing demand: Estimation and policy implications. *International Economic Review,* 54**,** 409-442.

BAMFORD, G. 2009. Urban form and housing density, Australian cities and European models: Copenhagen and Stockholm reconsidered. *Urban Policy and Research,* 27**,** 337-356.

BARTON, H. 2013. *Sustainable communities: The potential for eco-neighbourhoods,* Routledge.

BERSON, D. W. & BERSON, D. L. 1997. The importance of demographics in economic analysis: the unusual suspects. *Business Economics***,** 12-16.

BERTINELLI, L. & STROBL, E. 2007. Urbanisation, urban concentration and economic development. *Urban Studies,* 44**,** 2499-2510.

BILSBORROW, R. E. 1998. *Migration, urbanization, and development: new directions and issues,* Springer Science & Business Media.

BOEHM, T. P. & MCKENZIE, J. A. 1982. Inflation, taxes, and the demand for housing. *Real Estate Economics,* 10**,** 25-38.

BRADY, E. A. 1967. A sectoral econometric study of the postwar residential-housing market. *Journal of Political Economy,* 75**,** 147-158.

BRAMLEY, G. & POWER, S. 2009. Urban form and social sustainability: the role of density and housing type. *Environment and Planning B: Planning and Design,* 36**,** 30-48.

BREHENY, M. 1992. The contradictions of the compact city. *Sustainable Development and Urban Form***,** 138-159.

BRENNER, N. & THEODORE, N. 2002. Cities and the geographies of "actually existing neoliberalism". *Antipode,* 34**,** 349-379.

BROITMAN, D. & KOOMEN, E. 2015. Residential density change: Densification and urban expansion. *Computers, Environment and Urban Systems,* 54**,** 32-46.

BROOKFIELD, H. & BYRON, Y. 1993. *South-East Asia's environmental future: the search for sustainability,* United Nations University Press.

BRYMAN, A. 2016. *Social research methods,* Oxford university press.

BURTON, E. 2002. Measuring urban compactness in UK towns and cities. *Environment and Planning B: Planning and Design,* 29**,** 219-250.

BURTON, E., JENKS, M. & WILLIAMS, K. 2003. *The compact city: a sustainable urban form?*, Routledge.
CAO, N. 2015. The ranking of housing price to income ratio for 35 large and medium-sized Chinese cities in 2014 *E-house China.*
CARLINER, G. 1973. Income elasticity of housing demand. *The Review of Economics and Statistics***,** 528-532.
CEC 1990. Green Paper on the Urban Environment. *EUR 12902 EN***,** 45.
CHAN, K. W. & ZHANG, L. 1999. The hukou system and rural-urban migration in China: Processes and changes. *The China Quarterly,* 160**,** 818-855.
CHEN, C. 2006. Determination Mechanism of Urban Residential Plot Ratio. *Urban Issues***,** 6-10.
CHEN, C. & XIAO, D. 2007. Analysis on Strengthen Borders of High Floor Area Ratio of Living Space. *Planner,* 23**,** 87-90.
CHEN, H., JIA, B. & LAU, S. 2008. Sustainable urban form for Chinese compact cities: Challenges of a rapid urbanized economy. *Habitat international,* 32**,** 28-40.
CHEN, J. 2016. Housing system and urbanization in the People's Republic of China.
CHEN, J., GUO, F. & WU, Y. 2011a. Chinese urbanization and urban housing growth since the mid-1990s. *Journal of Housing and the Built Environment,* 26**,** 219-232.
CHEN, J., GUO, F. & WU, Y. 2011b. One decade of urban housing reform in China: Urban housing price dynamics and the role of migration and urbanization, 1995–2005. *Habitat International,* 35**,** 1-8.
CHEN, J. & JIN, M. 2014. Income elasticity of housing demand in China: micro-data evidence from Shanghai. *Journal of Contemporary China,* 23**,** 68-84.
CHEN, J. & ZHU, A. 2008. The relationship between housing investment and economic growth in China: A panel analysis using quarterly provincial data. Working Paper, Department of Economics, Uppsala University.
CHEN, M., ZHANG, H., LIU, W. & ZHANG, W. 2014. The global pattern of urbanization and economic growth: evidence from the last three decades. *PloS one,* 9**,** e103799.
CHENG, V. 2010. Understanding density and high density. *Designing high-density cities for social and environmental sustainability***,** 3-17.
CHENG, Y., XIAOHUI, W. & SHIMOU, Y. 2016. The Urbanization Pattern of China in the 21st Century. *Journal of US-China Public Administration,* 13**,** 145-155.
CHI, G., LIU, Y., WU, Z. & WU, H. 2015. Ghost cities analysis based on positioning data in China. *arXiv preprint arXiv:1510.08505.*
CHOW, G. C. & NIU, L. 2010. Demand and supply for residential housing in urban China. *Journal of Financial research,* 44**,** 1-11.
CHOW, G. C. & NIU, L. 2015. Housing prices in urban China as determined by demand and supply. *Pacific Economic Review,* 20**,** 1-16.
COURGEAU, D. & LELIèVRE, E. 2006. *Individual and social motivations for migration*, na.
DANESHPOUR, A. & SHAKIBAMANESH, A. 2011. Compact city; dose it create an obligatory context for urban sustainability? *Iran University of Science & Technology,* 21**,** 110-118.
DASGUPTA, B., LALL, S. V. & LOZANO GRACIA, N. 2014. Urbanization and housing investment.
DAVID, M. H. 1962. *Family composition and consumption*, North-Holland Publishing Company.
DAVIS, J. C. & HENDERSON, J. V. 2003. Evidence on the political economy of the urbanization process. *Journal of urban economics,* 53**,** 98-125.

DAWKINS, C. J. & NELSON, A. C. 2002. Urban containment policies and housing prices: an international comparison with implications for future research. *Land Use Policy,* 19**,** 1-12.

DE LEEUW, F. 1971. The demand for housing: A review of cross-section evidence. *The Review of Economics Statistic***,** 1-10.

DELMELLE, E. C., ZHOU, Y. & THILL, J.-C. 2014. Densification without growth management? Evidence from local land development and housing trends in Charlotte, North Carolina, USA. *Sustainability,* 6**,** 3975-3990.

DEMPSEY, N., BROWN, C. & BRAMLEY, G. 2012. The key to sustainable urban development in UK cities? The influence of density on social sustainability. *Progress in Planning,* 77**,** 89-141.

DENG, L., SHEN, Q. & WANG, L. 2009. Housing policy and finance in China: A literature review. *US Department of Housing and Urban Development*.

DENG, L., SHEN, Q. & WANG, L. 2011a. The emerging housing policy framework in China. *Journal of Planning Literature,* 26**,** 168-183.

DENG, Y., MORCK, R., WU, J. & YEUNG, B. 2011b. Monetary and fiscal stimuli, ownership structure, and China's housing market. National Bureau of Economic Research.

DEPARTMENT OF THE ENVIRONMENT TRANSPORT AND THE REGIONS 1998. *The use of density in urban planning,* London, Dept. of the Environment, Transport and the Regions.

DıAZ, A. & LUENGO-PRADO, M. J. 2011. The user cost, home ownership and housing prices: Theory and evidence from the US.

DIJKSTRA, L. & POELMAN, H. 2014. A harmonised definition of cities and rural areas: the new degree of urbanisation. *WP,* 1**,** 2014.

DIPASQUALE, D. & WHEATON, W. C. 1994. Housing market dynamics and the future of housing prices. *Journal of urban economics,* 35**,** 1-27.

DONG, L. 2001. urbanisation and housing issues. *Urban Planning Overseas***,** 21-24.

DRAKAKIS-SMITH, D. 2012. *Urbanisation, housing and the development process,* Routledge.

DREGER, C. & ZHANG, Y. 2013. Is there a bubble in the Chinese housing market? *Urban Policy and Research,* 31**,** 27-39.

DUSANSKY, R. & WILSON, P. W. 1993. The demand for housing: Theoretical considerations. *Journal of Economic Theory,* 61**,** 120-138.

DYER JR, W. G. & WILKINS, A. L. 1991. Better stories, not better constructs, to generate better theory: A rejoinder to Eisenhardt. *Academy of management review,* 16**,** 613-619.

EBANKS, G. E. & CHENG, C. 1990. China: a unique urbanization model. *Asia-Pacific Population Journal,* 5**,** 29-50.

EICHHOLTZ, P. & LINDENTHAL, T. 2014. Demographics, human capital, and the demand for housing. *Journal of housing economics,* 26**,** 19-32.

EISENHARDT, K. M. 1991. Better stories and better constructs: The case for rigor and comparative logic. *Academy of Management review,* 16**,** 620-627.

ELLIS, L. 2005. Disinflation and the dynamics of mortgage debt. *Investigating the Relationship between the Financial and Real Economy***,** 5-20.

ENGEL, E. 1857. Die productions und consumtionsverhaltnisse des konigsreichs sachsen. *Zietscrift des Statischen Bureaus des Koniglich Sachischen Ministeriums des Innern,* 3.

EWING, R. 1997. Is Los Angeles-style sprawl desirable? *Journal of the American planning association,* 63**,** 107-126.

EWING, R. & RONG, F. 2008. The impact of urban form on US residential energy use. *Housing policy debate,* 19**,** 1-30.
FAIR, R. C. 1972. Disequilibrium in housing models. *The Journal of Finance,* 27**,** 207-221.
FAN, C. C. 2008. Migration, hukou, and the city. *China urbanizes: Consequences, strategies, and policies***,** 65-89.
FONTENLA, M. & GONZALEZ, F. 2009. Housing demand in Mexico. *Journal of Housing Economics,* 18**,** 1-12.
FORCE URBAN TASK 1999. *Towards an Urban Renaissance: The Report of the Urban Task Force Chaired by Lord Rogers of Riverside: Executive Summary,* Urban Task Force.
FRIEDMANN, J. 2002. *The prospect of cities*, U of Minnesota Press.
FULLER, R. & CRAWFORD, R. 2011. Impact of past and future residential housing development patterns on energy demand and related emissions. *Journal of housing and the built environment,* 26**,** 165-183.
GALSTER, G., HANSON, R., RATCLIFFE, M. R., WOLMAN, H., COLEMAN, S. & FREIHAGE, J. 2001. Wrestling sprawl to the ground: defining and measuring an elusive concept. *Housing policy debate,* 12**,** 681-717.
GLAESER, E. L., GYOURKO, J. & SAKS, R. E. 2005. Urban growth and housing supply. *Journal of economic geography,* 6**,** 71-89.
GOODMAN, A. C. 2003. Following a panel of stayers: Length of stay, tenure choice, and housing demand. *Journal of Housing Economics,* 12**,** 106-133.
GORDON, P. & RICHARDSON, H. W. 1997. Are compact cities a desirable planning goal? *Journal of the American planning association,* 63**,** 95-106.
GREEN, R. K. 1997. Follow the Leader: How Changes in Residential and Non‐residential Investment Predict Changes in GDP. *Real Estate Economics,* 25**,** 253-270.
GREGORY, D., JOHNSTON, R., PRATT, G., WATTS, M. & WHATMORE, S. 2011. *The dictionary of human geography,* John Wiley & Sons.
GRIES, T. & GRUNDMANN, R. 2018. Fertility and modernization: the role of urbanization in developing countries. *Journal of International Development,* 30**,** 493-506.
GU, C., JIANMING, C., WEI, Z. & QINGYU, M. 1999. A STUDY ON THE PATTERNS OFM IGRATION IN CHINESE LARGE AND M ED IUM CITIES.
GUSTAFSSON, J. 2017. Single case studies vs. multiple case studies: A comparative study.
HALL, P. 2001. 7 Sustainable Cities or Town Cramming? *Planning for a sustainable future***,** 101.
HAN, R., TONG, L., TONG, W. & YU, J. 2011. Coordinated evolvement of dynamic coupling between economic and environmental systems in Shenyang Metropolitan Area. *Chinese Journal of Applied Ecology,* 22**,** 2673-2680.
HAN, S. 1998. Real estate development in China: a regional perspective. *Journal of Real Estate Literature,* 6**,** 121-133.
HARRIS, R. & ARKU, G. 2006. Housing and economic development: The evolution of an idea since 1945. *Habitat International,* 30**,** 1007-1017.
HARVEY, D. 2005. *A brief history of neoliberalism,* Oxford, Oxford University Press.
HAUGHTON, G. & HUNTER, C. 2004. *Sustainable cities*, Routledge.
HAYDEN, D. 1982. *The grand domestic revolution: A history of feminist designs for American homes, neighborhoods, and cities,* mit Press.

HE, Q. 1996. The Connotation of Floor Area Ratio and the Index System. *Urban Planning***,** 25-27.
HE, S. & WU, F. 2005. Property-led redevelopment in post-reform China: A case study of Xintiandi redevelopment project in Shanghai. *Journal of Urban Affairs,* 27**,** 1-23.
HE, S. & WU, F. 2009. China's emerging neoliberal urbanism: perspectives from urban redevelopment. *Antipode,* 41**,** 282-304.
HEATH, S. 2014. Housing demand and need (England). *England: House of Commons Library*.
HENDERSON, J. V. 1991. Urban development: Theory, fact, and illusion. *OUP Catalogue*.
HENDERSON, J. V. 2000. *How urban concentration affects economic growth*, World Bank Publications.
HENDERSON, V. 2003. The urbanization process and economic growth: The so-what question. *Journal of Economic growth,* 8**,** 47-71.
HU, Y. 2003. *Study of system dynamics for urban housing development in Hong Kong.* The Hong Kong Polytechnic University.
HUANG, X., DIJST, M., VAN WEESEP, J. & ZOU, N. 2014. Residential mobility in China: home ownership among rural–urban migrants after reform of the hukou registration system. *Journal of Housing and the Built Environment,* 29**,** 615-636.
HUANG, Y. 2004. Housing markets, government behaviors, and housing choice: a case study of three cities in China. *Environment and Planning A,* 36**,** 45-68.
HUI, C. 2004. Analysis of land use policy and patterns: Hong Kong.
IOANNIDES, Y. M. & ZABEL, J. E. 2003. Neighbourhood effects and housing demand. *Journal of applied Econometrics,* 18**,** 563-584.
JENKS, M. & JONES, C. 2009. *Dimensions of the sustainable city*, Springer Science & Business Media.
JONES, T., GATZLAFF, D. & SIRMANS, G. S. 2016. Housing Market Dynamics: Disequilibrium, Mortgage Default, and Reverse Mortgages. *The Journal of Real Estate Finance and Economics,* 53**,** 269-281.
JORDAN, M., MEYER, W. B., KATES, R. W., CLARK, W. C., RICHARDS, J. F., TURNER, B. L. & MATHEWS, J. T. 1990. *The earth as transformed by human action: global and regional changes in the biosphere over the past 300 years*, CUP Archive.
KAIN, J. F. & QUIGLEY, J. M. 1975. Housing markets and racial discrimination: A microeconomic analysis. *NBER Books*.
KENNETT, P. & MIZUUCHI, T. 2010. Homelessness, housing insecurity and social exclusion in China, Hong Kong, and Japan. *City, Culture and Society,* 1**,** 111-118.
KNOX, P. & PINCH, S. 2014. *Urban social geography: an introduction*, Routledge.
KUMARANAYAKE, L. 2000. The real and the nominal? Making inflationary adjustments to cost and other economic data. *Health Policy and Planning,* 15**,** 230-234.
LA CAVA, G. D. 2016. Housing prices, mortgage interest rates and the rising share of capital income in the United States.
LARDY, N. R. 2004. *Integrating China into the global economy*, Brookings Institution Press.
LARDY, N. R. & SUBRAMANIAN, A. 2011. *Sustaining China's economic growth after the global financial crisis*, Peterson Institute.
LEE, L.-F. & TROST, R. P. 1978. Estimation of some limited dependent variable models with application to housing demand. *Journal of Econometrics,* 8**,** 357-382.

LEE, T. H. & KONG, C. M. 1977. Elasticities of housing demand. *Southern Economic Journal***,** 298-305.
LI, J., HU, Y., CHEN, W., LIU, M., HU, J., ZHONG, Q. & LU, N. 2012a. Spatial Distribution Characteristics of Urban Potential Population in Shenyang Based on QuickBird and GIS. *Journal of Applied Ecology,* 23**,** 1649-1654.
LI, M. 1973. An Analysis of Housing Consumption with Implications for the Design of a Housing Allowance Program. *Analysis of Selected Census and Welfare Program Data to Determine Relations of Household Characteristics, and Administrative Welfare Policies to a Direct Housing Assistance Program***,** 5-222.
LI, S.-M. 2005a. Residential mobility and urban change in China. *Restructuring the Chinese City: Changing Society, Economy and Space***,** 157-171.
LI, X.-H., LIU, J.-L., GIBSON, V. & ZHU, Y.-G. 2012b. Urban sustainability and human health in China, East Asia and Southeast Asia. *Current Opinion in Environmental Sustainability,* 4**,** 436-442.
LI, X., FLORAX, R. & WALDORF, B. Agricultural productivity and urbanization. A smooth coefficient regression analysis. W] Annual Meeting of Agricultural and Applied Economics Association, 2014.
LI, X., ZHANG, Y. & CHEN, G. 2005. A Demand Side Analysis on China‟ s Engines of Economic Growth. *Quantitative & Technical Economics (in Chinese),* 11.
LI, Y. 2005b. Non-economic Factors Affecting Housing Demand in China. *Northern Economy***,** 33-34.
LI, Y. & DORSTEN, L. 2010. Regional and urban/rural differences of public health in China. *Global Journal of Health Science,* 2**,** p20.
LIANG, H. 1992. Reasonable Basis for Determining Floor Area Ratio. *Urban Planning***,** 58-60.
LIMMER, R. 1978. How Well Are We Housed? 2. Female-Headed Households.
LIN, G. C. 2001. Metropolitan development in a transitional socialist economy: spatial restructuring in the Pearl River Delta, China. *Urban Studies,* 38**,** 383-406.
LIN, J. 1994. Land Price, Floor Area Ratio, and Urban Planning. *Beijing Planning and Construction***,** 39-42.
LINNEMAN, P. 1986. A new look at the homeownership decision. *Housing Fin. Rev.*, 5**,** 159.
LIU, J., LIU, M., ZHUANG, D., ZHANG, Z. & DENG, X. 2003. Study on spatial pattern of land-use change in China during 1995–2000. *Science in China Series D: Earth Sciences,* 46**,** 373-384.
LIU, W., WU, J., LEE, M. V., LEE, J. & SECRETARIAT, L. C. 1996. Study of Housing Demand Model. *Hongkong. Research and Library Services Division Legislatif Council Secretariat*.
LOIBL, W. & TOETZER, T. 2003. Modeling growth and densification processes in suburban regions—simulation of landscape transition with spatial agents. *Environmental Modelling & Software,* 18**,** 553-563.
LONG, H., LIU, Y., HOU, X., LI, T. & LI, Y. 2014. Effects of land use transitions due to rapid urbanization on ecosystem services: Implications for urban planning in the new developing area of China. *Habitat International,* 44**,** 536-544.
LU, M. & WAN, G. 2014. Urbanization and urban systems in the People's Republic of China: research findings and policy recommendations. *Journal of Economic Surveys,* 28**,** 671-685.
MA, X. 2017. China's Housing Reform Process: A Comprehensive Review. Proceedings of the 16th National Academic Annual Conference.
MAISEL, S. J., BURNHAM, J. B. & AUSTIN, J. S. 1971. The demand for housing: A comment. *The Review of Economics and Statistics***,** 410-413.

MALPASS, P. 1986. *The housing crisis*, Routledge Kegan & Paul.
MALPEZZI, S. & MAYO, S. K. 1987. The demand for housing in developing countries: empirical estimates from household data. *Economic Development and Cultural Change,* 35**,** 687-721.
MAYER, C. J. & SOMERVILLE, C. T. 2000. Residential construction: Using the urban growth model to estimate housing supply. *Journal of urban economics,* 48**,** 85-109.
MAYO, S. K. 1981. Theory and estimation in the economics of housing demand. *Journal of Urban Economics,* 10**,** 95-116.
MCCARTHY, L. M. & KNOX, P. L. 2005. *Urbanization: An introduction to urban geography*, Pearson Prentice Hall.
MCLAREN, D. 1992. Compact or dispersed? Dilution is no solution. *Built Environment (1978-),* 268-284.
MEGBOLUGBE, I. & MARKS, A. 1991. The economic theory of housing demand: a critical review. *Journal of Real Estate Research,* 6**,** 381-393.
MEHMET, O. 2014. *Economic Planning and Social Justice in Third World Countries*, Routledge.
MESTHRIGE JAYANTHA, W. & LAU, S. S. Y. 2008. Floor space per person and housing development: an urban growth approach to estimate housing supply in Hong Kong. *Urban Policy and Research,* 26**,** 177-195.
MILLS, E. S. 1972. Studies in the Structure of the Urban Economy.
MILLS, E. S., BECKER, C. M. & VERMA, S. 1986. *Studies in Indian urban development*, Oxford University Press.
MOORE, D. 2004. The Second Age of the Third World: from primitive accumulation to global public goods? *Third World Quarterly,* 25**,** 87-109.
MULDER, C. H. 2006. Population and housing: A two sided relationship. *Demographic Research,* 15**,** 401-412.
MULFORD, J. E. 1979. *Income Elasticity of Housing Demand*, Rand Corporation.
MUTH, R. F. 1960. The demand for non-farm housing. *The demand for durable goods***,** 29-96.
MUTH, R. F. 1966. Household production and consumer demand functions. *Econometrica: Journal of the Econometric Society***,** 699-708.
MUTH, R. F. 1969. CITIES AND HOUSING; THE SPATIAL PATTERN OF URBAN RESIDENTIAL LAND USE.
NATIONAL BUREAU OF STATISTICS OF CHINA 2012. China Statistical Yearbook.
NATIONAL BUREAU OF STATISTICS OF CHINA 2017. China Statistical Yearbook.
NATIONAL REAL ESTATE INFORMATION CENTRE 2015. Chinese real estate market situation in 2014 and development prospects in 2015.
NEWMAN, P. G. & KENWORTHY, J. R. 1989. *Cities and automobile dependence: An international sourcebook*.
NG, E. 2009. *Designing high-density cities: for social and environmental sustainability*, Routledge.
NIKEGHBALI, S. 2017. *Density and Design The Impact of Urban Densification on Design Qualities in Residential Neighbourhoods.* PhD, Oxford Brookes University.
NORTHAM, R. M. 1979. *Urban geography*, John Wiley & Sons.
OLSEN, E. O. 1969. A competitive theory of the housing market. *The American Economic Review,* 59**,** 612-622.
PAN, X.-Z., ZHAO, Q.-G., CHEN, J., LIANG, Y. & SUN, B. 2008. Analyzing the variation of building density using high spatial resolution satellite images: the example of Shanghai City. *Sensors,* 8**,** 2541-2550.

PARKIN, M., POWELL, M. & MATTHEWS, K. 1997. Economics (3'd ed.). *Edinburgh Gate England: Addison Wesley Longman Ltd*.
PECK, J. & TICKELL, A. 2002. Neoliberalizing space. *Antipode,* 34**,** 380-404.
PENG, Z. 2006. The Relationship Research between the Real Estate Investment Fluctuate and Urbanization [J]. *East China Economic Management,* 10**,** 009.
PERREAULT, T. & MARTIN, P. 2005. Geographies of neoliberalism in Latin America. *Environment and Planning A,* 37**,** 191-201.
POLINSKY, A. M. 1977. The demand for housing: A study in specification and grouping. *Econometrica: Journal of the Econometric Society***,** 447-461.
PONT, M. B. & HAUPT, P. 2010. *Spacematrix: Space, Density, and Urban Form*, NAi.
POTERBA, J. M. 1984. Tax subsidies to owner-occupied housing: an asset-market approach. *The quarterly journal of economics,* 99**,** 729-752.
PRC. MINISTRY OF CONSTRUCTION 2011. Code for Classification and Urban and Rural Land Use and Planning Standards of Development Land.
PUGH, C. 2014. *Sustainability the Environment and Urbanisation*, Routledge.
QI, X., LI, X. & ZHOU, Y. Study on Shenyang's Vacant Commodity Housing Based on the Non-equilibrium of Supply and Demand. 2016 International Conference on Architectural Engineering and Civil Engineering, 2016. Atlantis Press.
QIANQIAN, Z. 2011. The impact of international oil price fluctuation on China's economy. *Energy Procedia,* 5**,** 1360-1364.
QUIGLEY, J. M. 1976. Housing demand in the short run: An analysis of polytomous choice. *Explorations in Economic Research, Volume 3, number 1*. NBER.
REMLER, D. K. & VAN RYZIN, G. G. 2010. *Research methods in practice: Strategies for description and causation*, Sage Publications.
ROBINSON, J. 2004. Squaring the circle? Some thoughts on the idea of sustainable development. *Ecological economics,* 48**,** 369-384.
RON, A. 2002. Regression analysis and the philosophy of social science: A critical realist view. *Journal of Critical Realism,* 1**,** 119-142.
ROUSSEAU, D. & CHEN, Y. 2001. Sustainability options for China's residential building sector. *Building Research & Information,* 29**,** 293-301.
SAIZ, A. 2010. The geographic determinants of housing supply. *The Quarterly Journal of Economics,* 125**,** 1253-1296.
SAKS, R. E. 2008. Job creation and housing construction: Constraints on metropolitan area employment growth. *Journal of Urban Economics,* 64**,** 178-195.
SATTERTHWAITE, D. 2005. *The scale of urban change worldwide 1950-2000 and its underpinnings*, IIED.
SAUR-AMARAL, I. 2011. Towards a methodology for literature reviews in social sciences. *investigaçao e Intervençâo em Recursos Humanos***,** 1-10.
SCARPACI, J. L. 2000. On the transformation of socialist cities. *Urban geography,* 21**,** 659-669.
SCOFFHAM, E. & VALE, B. 1996. How compact is sustainable—how sustainable is compact. *The compact city: A sustainable urban form***,** 66-73.
SHAW, V. N. 1997. Urban housing reform in China. *Habitat International,* 21**,** 199-212.
SHEN, J. 2006. Understanding dual-track urbanisation in post-reform China: conceptual framework and empirical analysis. *Population, Space and place,* 12**,** 497-516.
SHEN, L., PENG, Y., ZHANG, X. & WU, Y. 2012. An alternative model for evaluating sustainable urbanization. *Cities,* 29**,** 32-39.
SHENYANG PLANNING AND LAND SOURCE BUREAU 2013. Shenyang Urban overall development proposed plan 2011-2020.

SHENYANG STATISTICAL BUREAU 1996. Shenyang Yearbook 1996. Shenyang Bureau of Statistics.
SHENYANG STATISTICAL BUREAU 1997. Shenyang Yearbook 1997. Shenyang Bureau of Statistics.
SHENYANG STATISTICAL BUREAU 1998. Shenyang Yearbook 1998. Shenyang Bureau of Statistics.
SHENYANG STATISTICAL BUREAU 1999. Shenyang Yearbook 1999. Shenyang Bureau of Statistics.
SHENYANG STATISTICAL BUREAU 2000. Shenyang Yearbook 2000. Shenyang Bureau of Statistics.
SHENYANG STATISTICAL BUREAU 2001. Shenyang Yearbook 2001. Shenyang Bureau of Statistics.
SHENYANG STATISTICAL BUREAU 2002. Shenyang Yearbook 2001. Shenyang Bureau of Statistics.
SHENYANG STATISTICAL BUREAU 2011. Shenyang Yearbook 2011. Shenyang Bureau of Statistics.
SHENYANG STATISTICAL BUREAU 2013. Shenyang Yearbook 2013. Shenyang Bureau of Statistics.
SHENYANG STATISTICAL BUREAU 2014. Shenyang Yearbook 2014. Shenyang Bureau of Statistics.
SHENYANG STATISTICAL BUREAU 2015. Shenyang Statistical Yearbook 2015. Shenyang Statistical Bureau.
SIGGELKOW, N. 2007. Persuasion with case studies. *Academy of management journal,* 50**,** 20-24.
SIMONTON, D. K. 1977. Cross-sectional time-series experiments: Some suggested statistical analyses. *Psychological Bulletin,* 84**,** 489.
SKABURSKIS, A. 1997. Gender differences in housing demand. *Urban Studies,* 34**,** 275-320.
SKABURSKIS, A. 1999. Modelling the choice of tenure and building type. *Urban studies,* 36**,** 2199-2215.
SMARZYNSKA JAVORCIK, B. 2004. Does foreign direct investment increase the productivity of domestic firms? In search of spillovers through backward linkages. *American economic review,* 94**,** 605-627.
SMITH, N. 2002. New globalism, new urbanism: gentrification as global urban strategy. *Antipode,* 34**,** 427-450.
SNYDER, H. 2019. Literature review as a research methodology: An overview and guidelines. *Journal of Business Research,* 104**,** 333-339.
SOMERVILLE, C. T. 1999. Residential construction costs and the supply of new housing: endogeneity and bias in construction cost indexes. *The Journal of Real Estate Finance and Economics,* 18**,** 43-62.
SOMMER, K., SULLIVAN, P. & VERBRUGGE, R. 2010. *Run-up in the house price-rent ratio: how much can be explained by fundamentals?,* US Department of Labor, Bureau of Labor Statistics, Office of Prices and Living Conditions.
SONG & GAO, B. 2007. Impacts of Foreign Capital flows on housing prices 1998-2006. 55-61.
SONG, S. & ZHANG, K. H. 2002. Urbanisation and city size distribution in China. *Urban Studies,* 39**,** 2317-2327.
SPANGENBERG, J. H. 2005. Economic sustainability of the economy: concepts and indicators. *International journal of sustainable development,* 8**,** 47-64.
SPENCE, M., ANNEZ, P. C. & BUCKLEY, R. M. 2008. *Urbanization and growth,* World Bank Publications.

STAKE, R. E. 1995. *The art of case study research*, Sage.
SUBRAMANIAN, N. 2007. Sustainability-Challenges and solutions. *IndIan ConCreTe Journal,* 81**,** 39.
TALTAVULL, P., KUANG, W. & LI, X. 2012. Does China face a housing affordability issue? Evidence from 35 cities in China. *International Journal of Housing Markets and Analysis*.
TAYLOR, J. B. 2007. Housing and monetary policy. National Bureau of Economic Research.
TAYLOR, Z. T. & VAN NOSTRAND, J. C. 2008. *Shaping the Toronto Region, Past, Present, and Future: An Exploration of the Potential Effectiveness of Changes to Planning Policies Governing Greenfield Land Development in the Greater Golden Horseshoe*, Neptis Foundation.
THOMAS, L. & COUSINS, W. 1996. The compact city: a successful, desirable and achievable urban form. *The compact city: A sustainable urban form***,** 53-65.
THORSEN, D. E. & LIE, A. 2006. What is neoliberalism. *Oslo, University of Oslo, Department of Political Science, Manuscript***,** 1-21.
TISDALE, H. 1942. The Process of Urbanization*. *Social Forces,* 20**,** 311-316.
TOPEL, R. & ROSEN, S. 1988. Housing investment in the United States. *Journal of Political Economy,* 96**,** 718-740.
TRANFIELD, D., DENYER, D. & SMART, P. 2003. Towards a methodology for developing evidence-informed management knowledge by means of systematic review. *British journal of management,* 14**,** 207-222.
TUROK, I. & MCGRANAHAN, G. 2013. Urbanization and economic growth: the arguments and evidence for Africa and Asia. *Environment and Urbanization,* 25**,** 465-482.
UNITED NATIONS 2018. World Urbanization Prospects: The 2018 Revision. United Nations New York.
UNITED NATIONS, D. 2015. World urbanization prospects: The 2014 revision. *United Nations Department of Economics and Social Affairs, Population Division: New York, NY, USA*.
VAJIRANIVESA, P. 2008. A Housing demand model: A case study of the Bangkok Metropolitan Region, Thailand.
VERMEULEN, W. & VAN OMMEREN, J. 2006. Housing supply and the interaction of regional population and employment. CPB Netherlands Bureau for Economic Policy Analysis.
WANG, S. & LIU, H. 2006. Real estate development investment level theoretical research and empirical analysis. *Architech Economy,* 6**,** 60-63.
WANG, X.-R., HUI, E. C.-M. & SUN, J.-X. 2017. Population migration, urbanization and housing prices: Evidence from the cities in China. *Habitat International,* 66**,** 49-56.
WANG, Y. & MURIE, A. 1996. The process of commercialisation of urban housing in China. *Urban Studies,* 33**,** 971-989.
WANG, Y. P. & MURIE, A. 1999. *Housing policy and practice in China*, Basingstoke, Macmillan.
WANG, Y. P. & MURIE, A. 2000. Social and spatial implications of housing reform in China. *International Journal of Urban and Regional Research,* 24**,** 397-417.
WANG, Y. P., SHAO, L., MURIE, A. & CHENG, J. 2012. The maturation of the neo-liberal housing market in urban China. *Housing Studies,* 27**,** 343-359.

WANG, Y. P., WANG, Y. & BRAMLEY, G. 2005. Chinese housing reform in state-owned enterprises and its impacts on different social groups. *Urban Studies,* 42**,** 1859-1878.
WEBER, I. 2018. China and Neoliberalism: Moving Beyond the China is/is not Neoliberal Dichotomy. *The SAGE Handbook of Neoliberalism***,** 219.
WEI, S.-J. & ZHANG, X. 2011. The competitive saving motive: Evidence from rising sex ratios and savings rates in China. *Journal of political Economy,* 119**,** 511-564.
WHEATON, W. C. 1990. Vacancy, search, and prices in a housing market matching model. *Journal of Political Economy,* 98**,** 1270-1292.
WILLIAMSON, J. G. 1988. Migration and urbanization. *Handbook of development economics,* 1**,** 425-465.
WONG, C. P. 2000. Central-local relations revisited the 1994 tax-sharing reform and public expenditure management in China. *China Perspectives***,** 52-63.
WOOLDRIDGE, J. M. 2015. *Introductory econometrics: A modern approach*, Nelson Education.
WORLD BANK 1992. China - Urban land management : options for an emerging market economy : The main report. Washington, DC: World Bank.
WU, F. 2001. China's recent urban development in the process of land and housing marketisation and economic globalisation. *Habitat International,* 25**,** 273-289.
WU, J., GYOURKO, J. & DENG, Y. 2012. Evaluating conditions in major Chinese housing markets. *Regional Science and Urban Economics,* 42**,** 531-543.
WU, W. & YANG, H. 2008. China's Residence Consumption and Level of Development during the Transition Period. *Review of Industrial Economics***,** 87-102.
WU, Z. & LI, D. 2010. *Urban Planning Theory*, China Architechture & Building Press.
WUNSCH, G. 2012. *Introduction to demographic analysis: principles and methods*, Springer Science & Business Media.
XIANG, W.-M., LU, X. & LI, J. 2007. Research on Relationship between the Level of Urbanization and the Growth of Real Estate Investment. *JOURNAL-CHONGQING JIANZHU UNIVERSITY,* 29**,** 106.
XU, J., XU, Q. & HE, F. 2012. Demographic Factors Behind Price Increases: International Experience and China Evidence. *World Economy,* 1**,** 24-42.
YANG, HUAN ZHANG & ZHENG, S. 2015. Elasticity Measurement of Housing Demand on Owner-occupied Housing. *Statistics and Decisions,* 14**,** 60-63.
YANG, X. 2004. *Study on Floor Area Ratio of Urban Residential Communities.* Xi'an University of Architecture and Technology.
YAO, S., LUO, D. & WANG, J. 2014. Housing development and urbanisation in China. *The World Economy,* 37**,** 481-500.
YE, L., MANDPE, S. & MEYER, P. B. 2005. What is "smart growth?"—Really? *Journal of Planning Literature,* 19**,** 301-315.
YEH, A. G.-O. & WU, F. 1999. The transformation of the urban planning system in China from a centrally-planned to transitional economy. *Progress in planning,* 51**,** 167-252.
YEH, A. G. High density living in Hong Kong. Proceedings of the Cities, Health and Well-being conference, London School of Economics and Alfred Herrhausen Society in partnership with the University of Hong Kong, Hong Kong, 2011. 31-32.
YI, C. D. & HUANG, Y. Q. 2014. Housing Consumption and Housing Inequality in Chinese Cities During the First Decade of the Twenty-First Century. *Housing Studies,* 29**,** 291-311.
YI, R. 2018. Eighteen Years of Golden Time in the Expansion of Real Estate Enpterprises

YIN, R. K. 2017. *Case study research and applications: Design and methods*, Sage publications.
YU, Z. & WANG, X. 2003. Study on the Depth, Open Space and Floor Area Ratio of Commercial Housing. *ArchiCreation*, 115-117.
YUE, W., LIU, Y. & FAN, P. 2013. Measuring urban sprawl and its drivers in large Chinese cities: The case of Hangzhou. *Land use policy,* 31**,** 358-370.
ZABEL, J. 2016. A dynamic model of the housing market: The role of vacancies. *The Journal of Real Estate Finance and Economics,* 53**,** 368-391.
ZAINAL, Z. 2007. Case study as a research method. *Jurnal Kemanusiaan,* 5.
ZENG, C., DENG, X., DONG, J. & HU, P. 2016. Urbanization and sustainability: comparison of the processes in "BIC" countries. *Sustainability,* 8**,** 400.
ZHAI, G. 2006. Thoughts on Determining the Floor Area Ratio of Residential Land. *Planner,* 22**,** 74-76.
ZHANG, C. 2014a. *Impact of China's Demographic Demand for Housing.* Southwest University of Finance.
ZHANG, F. 2014b. *Modelling the Housing Market and Housing Satisfaction in Urban China.* University of Bath.
ZHANG, K. H. 2002. What explains China's rising urbanisation in the reform era? *Urban Studies,* 39**,** 2301-2315.
ZHANG, M. & RASIAH, R. 2014. Institutional change and state-owned enterprises in China's urban housing market. *Habitat International,* 41**,** 58-68.
ZHEN, L., YONGCHUN, Y. & YUXIANG, L. 2008. Difference among the growth of GDP and urbanization of the provinces and the cities in west China since the reform and opening-up. *China Population, Resources and Environment,* 18**,** 19-26.
ZHENG, H. & LIU, S. 2005. INCOME ELASTICITY OF HOUSING DEMAND IN CHINA: MODEL, ESTIMATION AND FORECAST [J]. *China Civil Engineering Journal,* 7**,** 024.
ZHENG, S. 2003. The harmonious development between housing investment and GDP. *Urban Dev,* 10**,** 59-61.
ZHENG, S. & ZHANG, W. 2007. The Spatial Interaction of Housing Cost and Commuting Cost: Evidence from Beijing Market [J]. *Progress in Geography,* 2**,** 3542.
ZHENG, X., WEI, C., QIN, P., GUO, J., YU, Y., SONG, F. & CHEN, Z. 2014. Characteristics of residential energy consumption in China: Findings from a household survey. *Energy Policy,* 75**,** 126-135.
ZHONG, T. 2009. On the Rigid Demand of Housing. *economic Theory and Business Management,* 9**,** 16-21.
ZHOU, S. & CHEUNG, M. 2017. Hukou system effects on migrant children's education in China: Learning from past disparities. *International Social Work,* 60**,** 1327-1342.
ZHOU, Y. 1982. Work on the rule of relations between urbanization level and GDP. *Population & Economics,* 1**,** 28-33.
ZHOU, Z.-G. 1997. Forecasting sales and price for existing single-family homes: a VAR model with error correction. *Journal of Real Estate Research,* 14**,** 155-167.
ZHU, X. 1992. Determination of Indicators for Controlled Detailed Planning. *Urban Planning Journal***,** 31-33.
ZHU, Y. & LIN, B. 2004. Sustainable housing and urban construction in China. *Energy and Buildings,* 36**,** 1287-1297.

10.Appendix

Year	Key policies of Chinese housing development
1988	*The Implementation Plan for a Gradual Housing System Reform in Cities and Towns*
1988	*The Land Administration Law*
1991	*On Comprehensive Reform of the Urban Housing System*
1994	*The Decision on Deeping the Urban Housing Reform*
1998	*The Notification from the State Council on Further Deepening the Reform of the Urban Housing System and Accelerating Housing Construction*
1999	*The Explanation Notes of the Further Housing System Reform Plan for the Central Government Organisation in Beijing*
2003	*The Notice on Promoting the Continuous and Healthy Development of the Real Estate Markets*
2005	*The Suggestions on Works of Stabilising Housing Price*
2007	*The Suggestions of the State Council on Solving Difficulties of Urban Low-income Families in Housing*
2008	*The Several Opinions of the General Office of the State Council on Promoting the Healthy Development of the Real Estate Market*
2011	*The Notice of the General Office of the State Council on Further Improving Regulation of the Real Estate Market*
2013	*The Notice of the General Office of the State Council on Continuously Improving Regulation of the Real Estate Market*

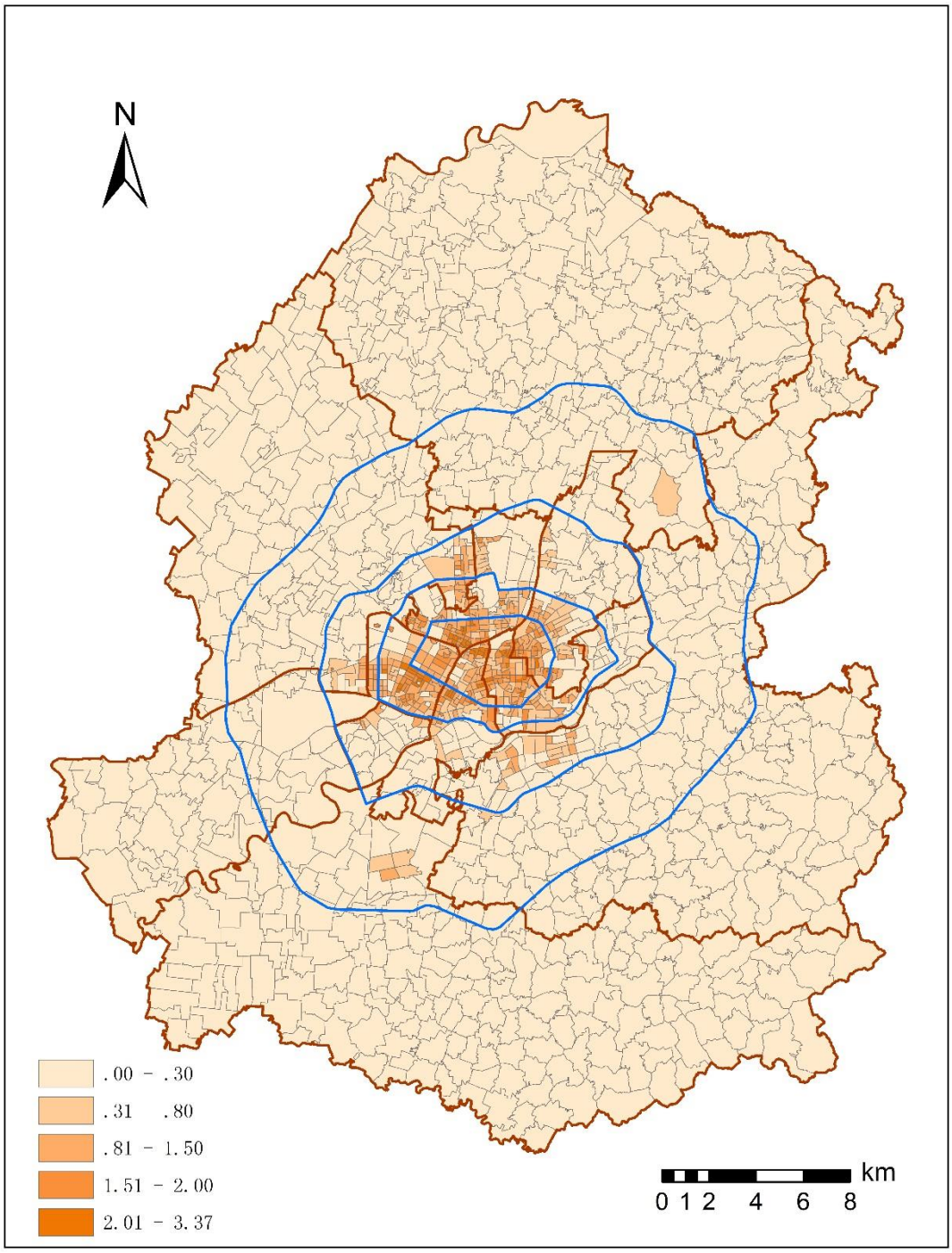
Appendix 1. Key policies of Chinese housing development

Source: State Council (years vary)

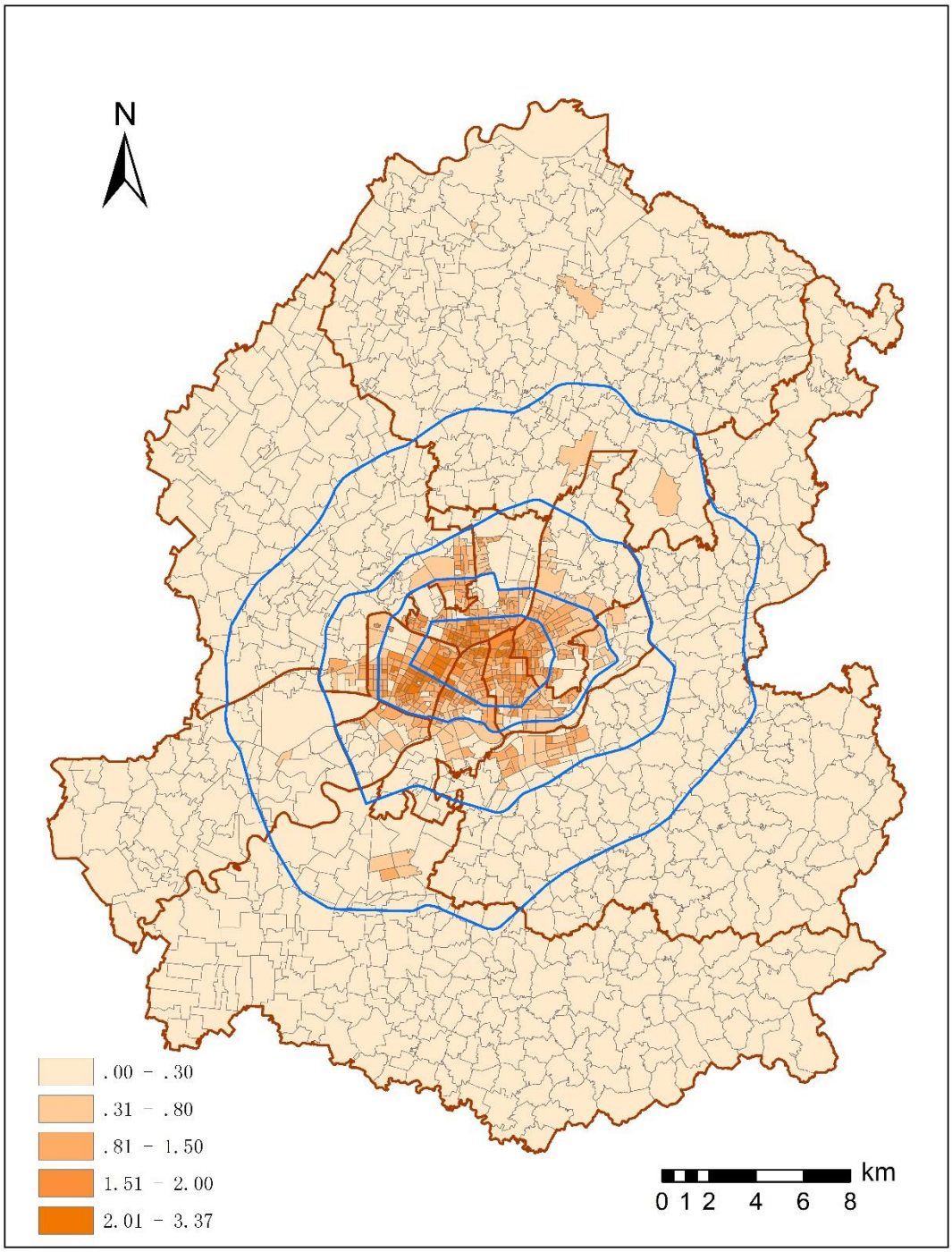
Year	Urban CPI (1978=1.000)
1995	4.296
1996	4.674
1997	4.819
1998	4.79
1999	4.728
2000	4.766
2001	4.799
2002	4.751
2003	4.794
2004	4.952
2005	5.031
2006	5.106
2007	5.336
2008	5.635
2009	5.584
2010	5.763
2011	6.068
2012	6.232
2013	6.375
2014	6.528

Appendix 2. The urban CPI of China from 1995 to 2014

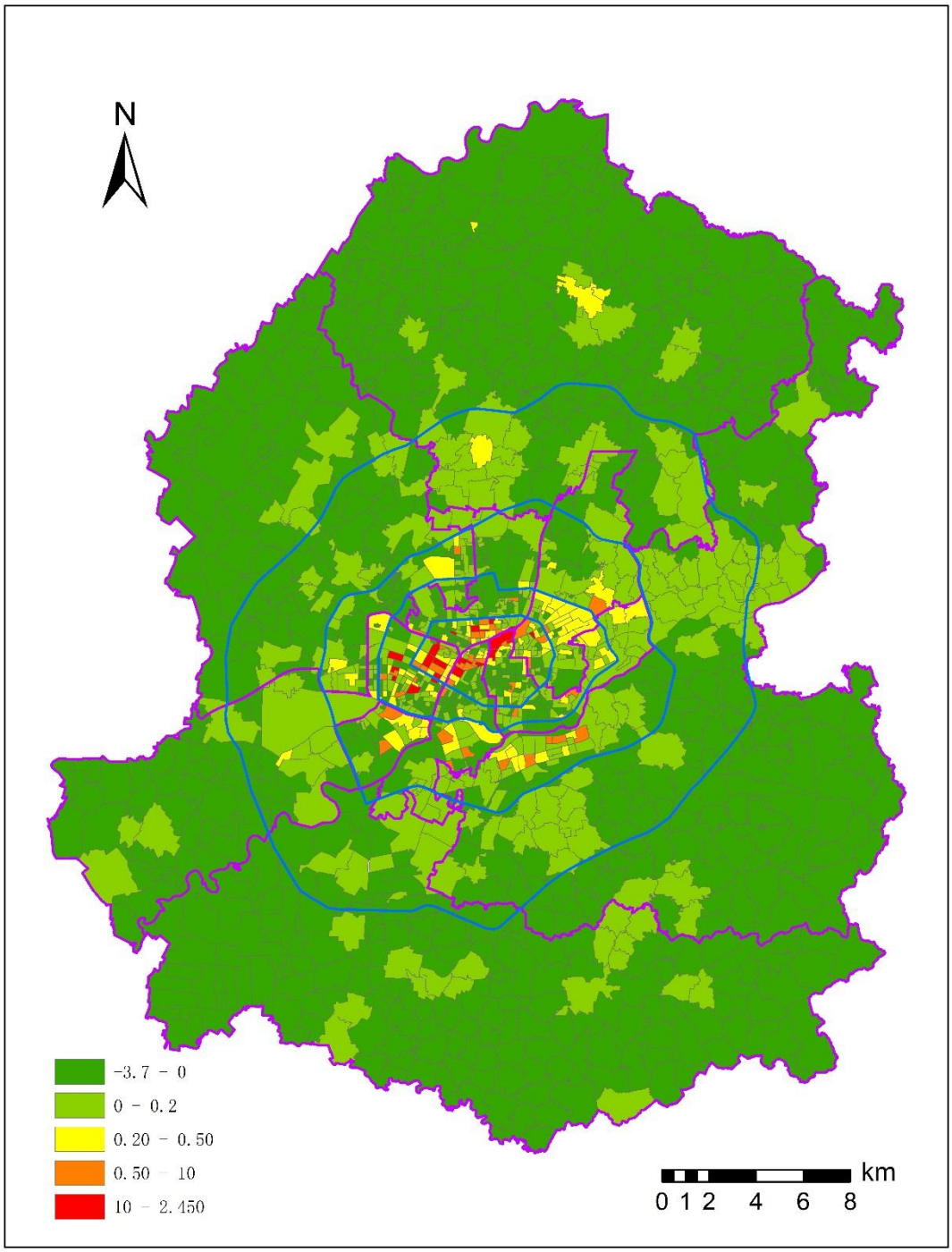
Source: CEIC, 2017



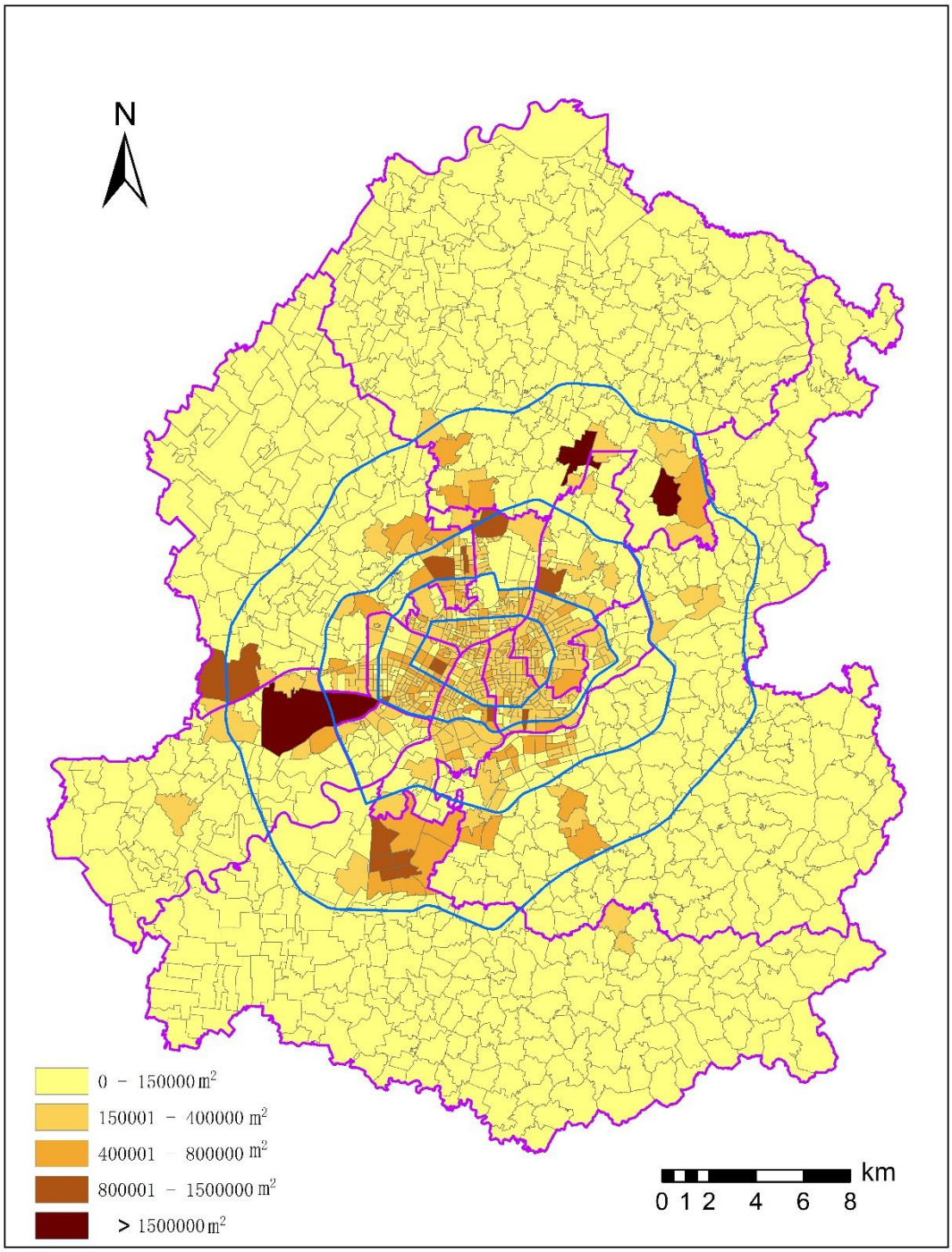
Appendix 3. The floor area ratio of Shenyang's housing in 2010



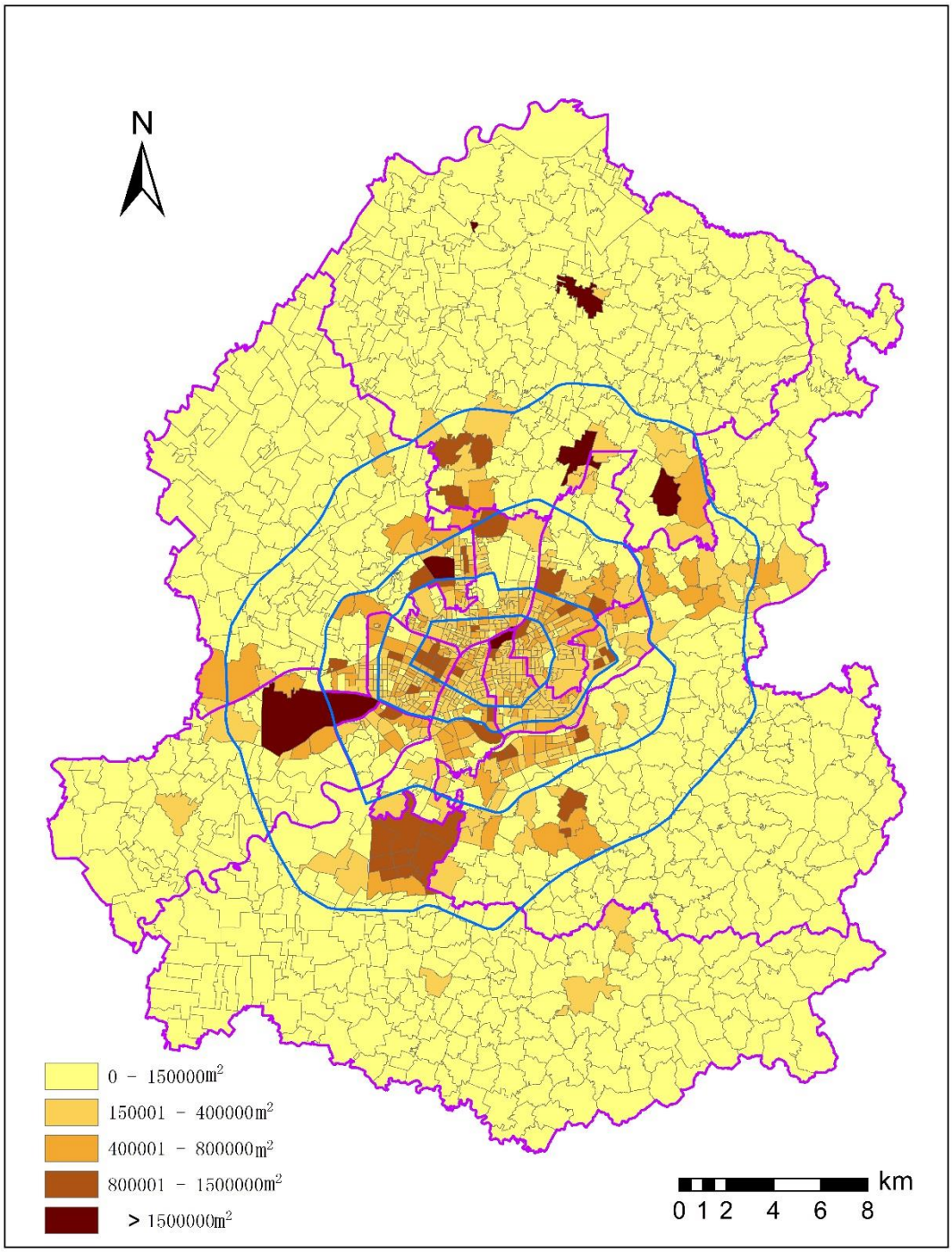
Appendix 4. The floor area ratio of Shenyang's housing in 2014



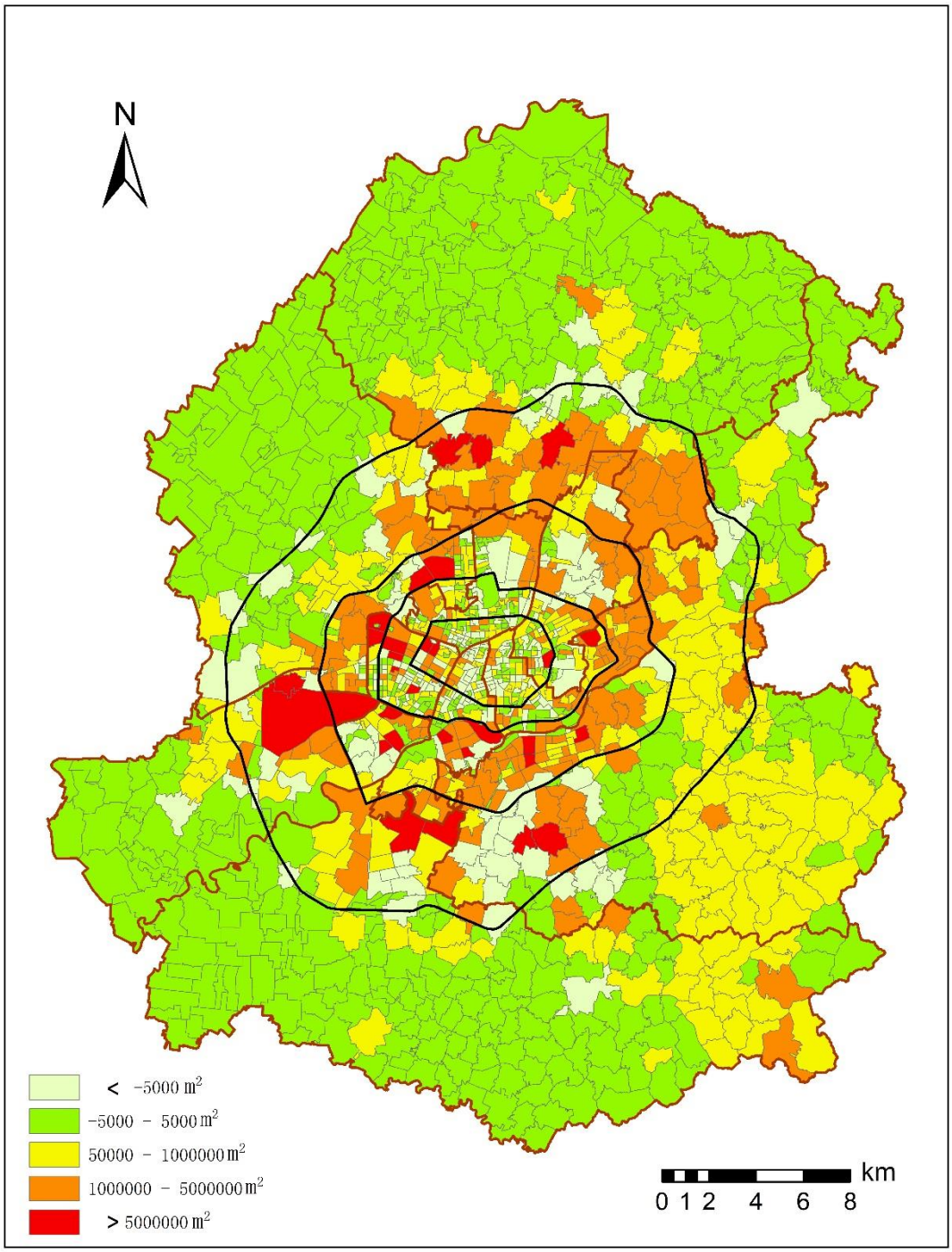
Appendix 5. The changes in floor area ratio of Shenyang's housing between 2010 and 2014



Appendix 6. Shenyang's housing stocks in 2010



Appendix 7. Shenyang's housing stocks in 2014



Appendix 8. The changes in Shenyang's housing stocks between 2010 and 2014

Appendix 9. Interview questions for the urban planners conducted in Shenyang Urban Planning Design and Research Institute

1. According to urban form, is Shenyang's urban development under a trend of urban compactness or urban sprawl? Or under both of them simultaneously?
2. What is the urban pattern of Shenyang? Is Shenyang under a monocentric development or polycentric development? Does the urban density of Shenyang decline exactly from the urban (geometrical) centre?
3. According to Section. 3 of Article. 3 of the *Shenyang Urban Overall Plan 2011-2020*, how much urban construction land will be used as the urban residential land? Are those land distributions balanced for the five urban districts? To what extent will it be sufficient for the housing demand in relation to urban population increases?
4. What are the principles which determine urban residential land scale? And how is urban residential land quantified? To what extent were the transitions from other land uses to residential land use under control in the last fifteen years?
5. Are there any compulsory index targets to achieve? (e.g. housing demand, floor area ratio, and optimum population capacity, open and green space area). How do these indexes influence the residential land planning and high-density living? Are those targets different for different urban districts and to what extent have these targets changes over time?
6. For new residential development, are the rules and principles different between the existing residential land and new-planned residential land? If so, why?

Appendix 10. Ethical approval form

School of the Built Environment
Research Ethical Guidelines, Procedure and Form

In keeping with directives from the European Union and from the UK Government, universities are required to put in place ethics procedures and guidelines for research. In addition, research councils including EPSRC ask for formal ethics approval of proposals in some of their funded programmes.

Heriot-Watt University has a University Ethics Committee to guide schools, monitor procedures and ensure appropriate ethical issues are being considered. In addition, a small ethics sub-committee of the school's Research Committee has been formed to deal with ethical approval procedures for research undertaken in SBE.

The University Ethics Committee has agreed an application form and procedure for considering ethical approval of research projects, and these have been adopted by PME for use in all Schools and Institutes.

This note outlines the context and general principles for ethical considerations in research, and provides the standard application form and protocol for ethics approval. The protocol will apply to all research in the school including research Masters and PhD work.

The form must be completed and returned to the Research Administrator: Claire Cook, Cathy Lord or Shauna Thompson (sberesearchadmin@hw.ac.uk). If the form is completed for PhD/MPhil student research, it must be returned to the Administrative Assistant (Research): Tom Hurst (sbe-pgr-students@hw.ac.uk). If the form is completed for MSc/MRes student research, it must be returned to the Postgraduate Administrator: Naomi Smith (sbepg@hw.ac.uk). If you have any queries about the form or procedure please contact James Morgan (**james.morgan@hw.ac.uk**).

General Ethical Principles

- No field of human activity can be considered exempt from ethical concerns. Increased accountability has led to systems of research governance to ensure that research methods and information are open to public scrutiny and can be seen to be subject to the highest ethical standards.
- Research should conform to generally accepted moral and scientific principles. There are:

a) Obligations to society:- i.e conforming with responsible, moral and legal practice; maintenance of high scientific standards and impartial assessment and dissemination of findings.

b) Obligations to funders and employers:- the relationship between researchers, funders, and employer should be clear and balanced without compromise to morality, the law or professional integrity.

c) Obligations to colleagues:- the maintenance of standards and appropriate professional behaviour with methods, procedures and findings open to review.

- Breaches of these principles include areas of research misconduct such as fabrication, falsification and plagiarism.
    - The well being of all involved in research is of central concern in ethical considerations. All staff are therefore obliged to comply with health and safety guidelines and to carry out a risk assessment of the research whatever its nature (e.g. laboratory work, field work, testing subjects etc). Further advice and **documentation on risk assessment** can be found by following the hyperlink above.

1

Ethical principles for research involving human subjects

One major obligation of researchers which is not included in the above list is to the subjects who are involved in research. Social researchers must strive to protect subjects from undue harm arising as a consequence of their participation in research. This requires that subjects' participation should be voluntary, and as fully informed as possible. At the same time, no group should be disadvantaged by routinely being excluded from consideration. Subjects should also be aware of their entitlement to refuse to participate at any stage for whatever reason, and to withdraw data just supplied. Special considerations should be given to studies requiring informed consent from vulnerable participants. Such groups include children, those with an intellectual disability and those in a dependent relationship to the researcher or commissioning body (e.g. students in college or patients in a hospital).

a) For interviews / focus groups:

- All subjects to be fully informed of the nature of the research and to give informed consent prior to interview.
- Subjects to be given a plain language statement of the nature and purpose of the research.
- It is generally preferable not to identify individual subjects but, if the identification of subjects is necessary, subjects must be informed of this.
- No interview should be recorded without the permission of the subject.
- Interviews by telephone must meet the same conditions as face-to-face interviews.
- Written parental consent is required for interviews with subjects under 18 (16 in Scotland), unless such interviews take place in the presence of a parent or guardian or in an institutional setting were the institutional consent has been given).

b) Questionnaires: All written questionnaires must have an opening statement informing the subject of the nature and purpose of the research. Completion of the forms shall indicate evidence of informed consent.

c) Observational methods: Where behaviour patterns are observed without the subjects' knowledge, researchers should take care not to infringe the privacy of an individual or group. Where practical, an attempt should be made to obtain consent post hoc. Cultural variations in what constitutes public and private space should be acknowledged.

d) Photography: of human subjects in publicly accessible spaces is a legitimate research tool. However; if prejudicial to the subjects' interests or reputation, identifying features of the subject must be obscured.

e) Experimental or field testing of subjects: Ethical requirements for this situation are the same as for those applying to subject interviews.

More detailed reference documents are available which provide useful further guidance on these issues, notably, the Social Research Association's *Ethical Guidelines* (**http://www.the-sra.org.uk/documents/pdfs/ethics03.pdf**).

Ethical considerations include taking into account issues related to personal data collection, use and management. This is regulated by the Data Protection Act. The Act states that anyone who processes personal information must comply with eight principles, which make sure that personal information is:

- Fairly and lawfully processed
- Processed for limited purposes
- Adequate, relevant and not excessive
- Accurate and up to date
- Not kept for longer than is necessary
- Processed in line with your rights
- Secure
- Not transferred to other countries without adequate protection

Guidance on the Data Protection Act can be found at **http://www.ico.gov.uk/Home/for_organisations/data_protection_guide.aspx**

Heriot-Watt University Code of Practice governing recruitment of research participants
All research that seeks to recruit research participants through printed material or electronic communication, either within the University or outside it, must meet the requirements of this Code. All applications for ethical approval made to School/Institute Ethics Committees must confirm that this Code will be followed when participants are recruited. The SBE application form for ethical approval contains a question that allows such confirmation.

The Heriot-Watt University Code of Practice governing recruitment of research participants can be found by following the hyperlink above.

Protocol for consideration of ethical issues in SBE research

1. For **all** research projects in the School undertaken by staff and/or postgraduate research students the **staff member responsible for the research (PI or research supervisor)** needs to complete and sign the ethics approval form. **For postgraduate research, the student undertaking the research also needs to sign the form.**
2. For research in taught postgraduate and undergraduate courses the supervisor is responsible for determining whether there are any ethical concerns which warrant completion of the form and for completing the form should that be the case. Both the supervisor and the student need to sign the form.
3. The completed form must be submitted to the Research Administrator (or PG Research Assistant in the case of postgraduate student research) before the research goes ahead. If the project requires completion of an RPC form, the ethics form must be completed at the time of completing the RPC form.
4. **All** forms must have questions 1 to 7 completed and be signed. If the research does not involve human participants or living animals in any way no further parts need to be completed.
5. If the research **does** involve human participants or living animals in any way, then Sections B & C, which ask questions regarding ethical procedures and considerations, need to be completed.
6. If Sections B & C **do not** raise ethical concerns, Section D is **not** to be completed. The form is then submitted to the Research Administrator, who will then refer it to the Chair of the Ethics Subcommittee for noting and approval.

7. If Sections B or C **do** raise any ethical concerns, then Section D must be completed. The form is then submitted to the Research Administrator, who will refer it to the Chair of the Ethics Subcommittee. The Chair will submit the proposal to the full SBE Ethics Sub-committee for consideration and approval. If there is any doubt from even one member of the sub-committee about a particular research proposal, this will be referred to the appropriate external body (Animals (Scientific Procedures) Committee, Lothian Region Ethics Committee or the University Ethics Committee) for further scrutiny and a final decision. In some cases the member of staff responsible for the research may also wish to suggest up to two staff members with appropriate expertise to review the submission and report to the SBE Ethics Sub-committee if they think this is appropriate and helpful. Such suggestions may be made using section E.

Type of approval

- **In Principle** applies when the project design does not have full details of the methodology. An In Principle application should specify when Full approval would be sought.
- **Full** applies when the project design includes full details of the methodology.
- **Resubmission** applies when ethical approval has not been granted in a previous application, or when there have been sufficient changes in a project to warrant a new ethical approval application.

Postgraduate research students will normally be expected to apply for **In Principle** approval when they start their PG research, and for **Full** approval at the time of their First Year Report, when they are expected to have a fully defined research methodology.

STUDENT SURNAME or PROJECT NO:____JIANG_____

HERIOT-WATT UNIVERSITY

APPLICATION TO SCHOOL ETHICS COMMITTEE FOR ETHICAL APPROVAL FOR A RESEARCH PROJECT

Click on the grey boxes to insert text

Section A: Project Overview

1. Project Title:An analysis of urban residential densification and urban expansion of the city: the cas of Shenya

2. Approval sought: Full approval ☑ Re-Submission ☐ In principle ☐
   If 'In principle', when will full approval be sought?

Contact Information

3. Responsible Staff Member / Supervisor of student research:

   a) Name.....Chris McWilliams

   b) Telephone 01314514625

   c) Email .....c.mcwilliams@hw.ac.uk

4. Investigator (if different from Responsible Staff Member) / Student:

   a) Name.....

   b) Telephone .....

   c) Email .....

5. Duration of Proposed Project .....3 months

6. Anticipated Start Date:.....April, 2016

7. Does the proposed research involve human participants or living animals in any way? Yes ☑ No ☐

   Note: Involvement of human participants includes obtaining information from people through methods such as experiments, observation, surveys or interview, or any use of previously obtained personal data, or any use of human tissue samples.

   If your answer to Question 7 is 'yes' complete the rest of the form; if it is 'no', simply sign the declaration in section F at the end of the form.

8. Please provide a brief summary of the proposed study (if possible, in less than 300 words. Include an overview of the design, variables, and other ethically-pertinent considerations). Feel free to attach a document if convenient.

The fieldwork in Shenyang, China involves two stages: quantitative data collection, from Shenyang Planning and Design Institute, Shenyang Planning and Land Source Bureau, and the Shenyang Yearbook; and qualitative semi-structured interviews, in the planning department of Shenyang government, Shenyang Planning and Design Institution, and Shenyang Statistical Bureau, and Shenyang Planning and Land Source Bureau.

The purpose of quantitative data collection is to calculate three measures and some variables, including Densification share, Density increase, Expansion density, Residential density of Shenyang, Share of potentially available land for residential development, Residential growth (and per hectare), Share of land in residential development area, Migration growth with the densification/expansion. Then, statistical method will be be used for data analysis.

The purpose of qualitative interviews is to examine whether the quantitative outcome is balanced and positive for the Shenyang's urban development and whether the residential development follows the related policies.

Section B: Administration

		Yes	No
1.	Will participants be appropriately informed of: the aims of the study; their ethical rights; their expected contribution; and their subsequent debrief? For example, their right to withdraw, any deception employed or potential consequences of the study.	☑	☐
2.	Will consent be obtained from all appropriate parties?	☑	☐
3.	Will the Heriot-Watt University Code of Practice governing recruitment of research participants be followed? (Code of Practice available at Code of Practice governing recruitment of research participants)	☑	☐

Section C: Ethical Considerations

		Yes	No
1.	Will the study require participants to potentially experience stressful or unpleasant situations?	☐	☑
2.	Will the data collection and management (storage & disposal) potentially compromise the interests of the participants? For example, body fluids, tissue samples or other personally identifiable materials, such as, visual, auditory or other data?	☐	☑
3.	Will payment or non-payment of participants have potentially negative implications in the study?	☐	☑
4.	Are there potential negative outcomes from the study for the participant? For example, compromise to or damage of, their physical, psychological, financial or social wellbeing.	☐	☑
5.	Are there any other potential negative outcomes from the study? For example, damage to property or risk of criminal or civil liability.	☐	☑
6.	Would you identify any other issues that may have potential ethical implications for your study?	☐	☑

If you responded 'No' to any questions in section B, or 'Yes' to any questions in section C, please now complete section D & E. Otherwise, proceed to section F.

Section D: Further Information Regarding Ethical Considerations

If you responded 'No' to any questions in section B, or 'Yes' to any questions in Section C, please provide further information, indicating how you would address this issue. Please be as comprehensive as possible, as this will speed the process for the referees and may avoid the need to contact you for further information or clarification.

Section E: Potential Referees (Optional)

If you have completed Section D, this form and any appended information will be reviewed by the full SBE Ethics Sub-committee. In addition, if you think it may be helpful for the review, you can suggest up to two staff members with appropriate expertise to review the submission.

1. Name ..... Contact .....

2. Name ..... Contact .....

Section F: DECLARATION

The information in this form is accurate to the best of my knowledge.

Signature of Responsible Staff Member (PI or research supervisor) ..... Chris McWilliam

Date 22/01/16

Signature of Student (if applicable) ..... Dashuai Jiang

Date 20/01/2016

Once completed this form should be returned to the Research Administrator: Claire Cook, Cathy Lord or Shauna Thompson (sberesearchadmin@hw.ac.uk). If the form is completed for PhD/MPhil student research, it must be returned to the Administrative Assistant (Research): Tom Hurst (sbe-pgr-students@hw.ac.uk). If the form is completed for MSc/MRes student research, it must be returned to the Postgraduate Administrator: Naomi Smith (sbepg@hw.ac.uk).

APPROVAL OF SECTIONS A.8, B, C & D (if completed)

I am satisfied that the researcher has properly considered the ethical implications of the intended study and has taken the appropriate action.

(Chair of SBE Ethics Sub-committee or delegated representative) ..... Hazel Smith

Date 24/03/16

FINAL APPROVAL

I am satisfied that the researcher has properly considered the ethical implications of the intended study and has taken the appropriate action.

(Head of School / Director of Research) ..... S. Goss

Date 31/03/2016

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Appendix 11. Informed consent for data

Informed Consent

Name of department: Shenyang Urban Planning Design and Research Institute

Title of the study: Urbanisation, Housing Demand and Densification, a case study of Shenyang, China

I confirm that I have read and understood the information about the study provided by Dachuan Jiang, and give consent to Dachuan Jiang to use ArcGIS data of housing density in the thesis of *Urbanisation, Housing Demand and Densification, a case study of Shenyang, China*.

Signatures: 

Date: 2016.7